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WO 03/095420 A1

(54) Title: HYDROXY TETRAHYDRO-NAPHTHALENYLUREA DERIVATIVES

(57) Abstract: This invention relates to tetrahydro-naphthalene derivatives and salts thereof which is useful as an active ingredient of pharmaceutical preparations. The tetrahydro-naphthalene derivatives of the present invention have an excellent activity as VR1 antagonist and useful for the prophylaxis and treatment of diseases associated with VR1 activity, in particular for the treatment of urge urinary incontinence, overactive bladder, chronic pain, neuropathic pain, postoperative pain, rheumatoid arthritic pain, neuralgia, neuropathies, algesia, nerve injury, ischaemia, neurodegeneration, stroke, incontinence, inflammatory disorders such as asthma and COPD.

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## HYDROXY TETRAHYDRO-NAPHTHALENYLUREA DERIVATIVES

### DETAILED DESCRIPTION OF INVENTION

5

#### TECHNICAL FIELD

The present invention relates to hydroxy-tetrahydro-naphthalenylurea derivatives which are useful as an active ingredient of pharmaceutical preparations. The 10 hydroxy-tetrahydro-naphthalenylurea derivatives of the present invention has vanilloid receptor (VR) antagonistic activity, and can be used for the prophylaxis and treatment of diseases associated with VR1 activity, in particular for the treatment of urge urinary incontinence, overactive bladder, chronic pain, neuropathic pain, postoperative pain, rheumatoid arthritic pain, neuralgia, neuropathies, algesia, nerve 15 injury, ischaemia, neurodegeneration, stroke, incontinence and/or inflammatory disorders such as asthma and chronic obstructive pulmonary disease (COPD).

Urinary incontinence (UI) is the involuntary loss of urine. Urge urinary incontinence (UUI) is one of the most common types of UI together with stress urinary incontinence (SUI) which is usually caused by a defect in the urethral closure mechanism. 20 UUI is often associated with neurological disorders or diseases causing neuronal damages such as dementia, Parkinson's disease, multiple sclerosis, stroke and diabetes, although it also occurs in individuals with no such disorders. One of the usual causes of UUI is overactive bladder (OAB) which is a medical condition 25 referring to the symptoms of frequency and urgency derived from abnormal contractions and instability of the detrusor muscle.

There are several medications for urinary incontinence on the market today mainly to help treating UUI. Therapy for OAB is focused on drugs that affect peripheral neural 30 control mechanisms or those that act directly on bladder detrusor smooth muscle contraction, with a major emphasis on development of anticholinergic agents. These

agents can inhibit the parasympathetic nerves which control bladder voiding or can exert a direct spasmolytic effect on the detrusor muscle of the bladder. This results in a decrease in intravesicular pressure, an increase in capacity and a reduction in the frequency of bladder contraction. Orally active anticholinergic drugs such as 5 propantheline (ProBanthine), tolterodine tartrate (Detrol) and oxybutynin (Ditropan) are the most commonly prescribed drugs. However, their most serious drawbacks are unacceptable side effects such as dry mouth, abnormal visions, constipation, and central nervous system disturbances. These side effects lead to poor compliance. Dry 10 mouth symptoms alone are responsible for a 70% non-compliance rate with oxybutynin. The inadequacies of present therapies highlight the need for novel, efficacious, safe, orally available drugs that have fewer side effects.

#### BACKGROUND ART

15 Vanilloid compounds are characterized by the presence of a vanillyl group or a functionally equivalent group. Examples of several vanilloid compounds or vanilloid receptor modulators are vanillin (4-hydroxy-3-methoxy-benzaldehyde), guaiacol (2-methoxy-phenol), zingerone (4-/4-hydroxy-3-methoxyphenyl/-2-butanone), eugenol-(2-methoxy4-/2-propenyl/phenol), and capsaicin (8-methy-N-vanillyl-6-nonene-20 amide).

Among others, capsaicin, the main pungent ingredient in "hot" chili peppers, is a 25 specific neurotoxin that desensitizes C-fiber afferent neurons. Capsaicin interacts with vanilloid receptors (VR1), which are predominantly expressed in cell bodies of dorsal root ganglia (DRG) or nerve endings of afferent sensory fibers including C-fiber nerve endings [Tominaga M, Caterina MJ, Malmberg AB, Rosen TA, Gilbert H, Skinner K, Raumann BE, Basbaum AI, Julius D: The cloned capsaicin receptor integrates multiple pain-producing stimuli. *Neuron*. 21: 531-543, 1998]. The VR1 receptor was recently cloned [Caterina MJ, Schumacher MA, Tominaga M, Rosen 30 TA, Levine JD, Julius D: *Nature* 389: 816-824, (1997)] and identified as a nonselective cation channel with six transmembrane domains that is structurally

related to the TRP (transient receptor potential) channel family. Binding of capsaicin to VR1 allows sodium, calcium and possibly potassium ions to flow down their concentration gradients, causing initial depolarization and release of neurotransmitters from the nerve terminals. VR1 can therefore be viewed as a molecular integrator of chemical and physical stimuli that elicit neuronal signals in a pathological conditions or diseases.

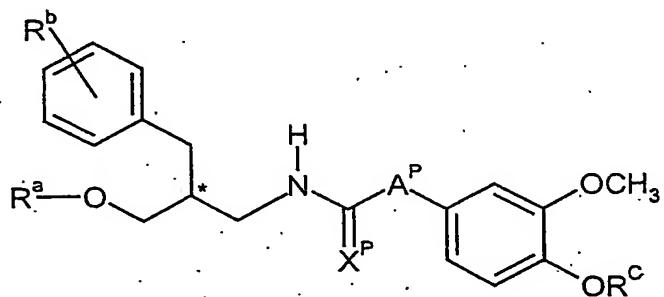
There are abundant of direct or indirect evidence that shows the relation between VR1 activity and diseases such as pain, ischaemia, and inflammatory (e.g., WO 10 99/00115 and 00/50387). Further, it has been demonstrated that VR1 transduce reflex signals that are involved in the overactive bladder of patients who have damaged or abnormal spinal reflex pathways [De Groat WC: A neurologic basis for the overactive bladder. *Urology* 50 (6A Suppl): 36-52, 1997]. Desensitisation of the afferent nerves by depleting neurotransmitters using VR1 agonists such as capsaicin 15 has been shown to give promising results in the treatment of bladder dysfunction associated with spinal cord injury and multiple sclerosis [(Maggi CA: Therapeutic potential of capsaicin-like molecules - Studies in animals and humans. *Life Sciences* 51: 1777-1781, 1992) and (DeRidder D; Chandiramani V; Dasgupta P; VanPoppel H; Baert L; Fowler CJ: Intravesical capsaicin as a treatment for refractory detrusor 20 hyperreflexia: A dual center study with long-term followup. *J. Urol.* 158: 2087-2092, 1997)].

It is anticipated that antagonism of the VR1 receptor would lead to the blockage of neurotransmitter release, resulting in prophylaxis and treatment of the condition and 25 diseases associated with VR1 activity.

It is therefore expected that antagonists of the VR1 receptor can be used for the prophylaxis and treatment of the condition and diseases including chronic pain, neuropathic pain, postoperative pain, rheumatoid arthritic pain, neuralgia, neuropathies, algesia, nerve injury, ischaemia, neurodegeneration, stroke, incontinence, 30

inflammatory disorders such as asthma and COPD, urinary incontinence (UI) such as urge urinary incontinence (UUI), and/or overactive bladder.

WO 00/50387 discloses the compounds having a vanilloid agonist activity represented by the general formula:



wherein;

10  $X^P$  is an oxygen or sulfur atom;

$A^P$  is  $-NHCH_2-$  or  $-CH_2-$ ;

$R^a$  is a substituted or unsubstituted  $C_{1-4}$  alkyl group, or  $R^{a1}CO-$ ;

15

wherein

20  $R^{a1}$  is an alkyl group having 1 to 18 carbon atoms, an alkenyl group having 2 to 18 carbon atoms, or substituted or unsubstituted aryl group having 6 to 10 carbon atoms;

$R^b$  is a hydrogen atom, an alkyl group having 1 to 6 carbon atoms, an alkoxy group having 1 to 6 carbon atoms, a haloalkyl group having 1 to 6 carbon atoms or a halogen atom;

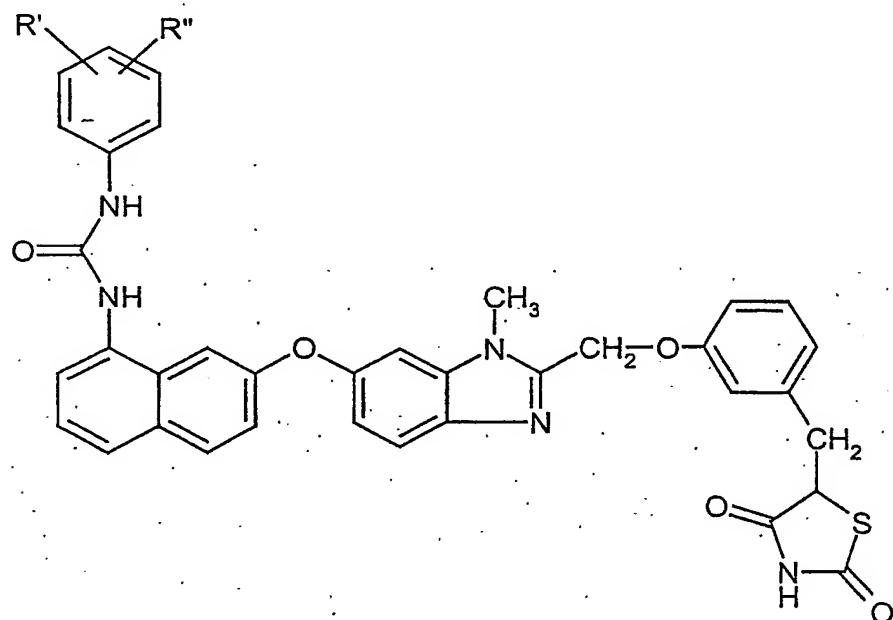
25

- 5 -

$R^C$  is a hydrogen atom, an alkyl group having 1 to 4 carbon atom, an aminoalkyl, a diacid monoester or  $\alpha$ -alkyl acid; and

5 the asteric mark \* indicates a chiral carbon atom, and their pharmaceutically acceptable salts.

WO 2000/61581 discloses amine derivatives represented by the general formula:



10 wherein

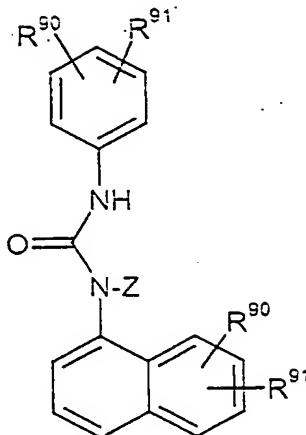
$(R', R'')$  represent (F, F), (CF<sub>3</sub>, H), or (iPr, iPr)

as useful agents for diabetes, hyperlipemia, arteriosclerosis and cancer.

15

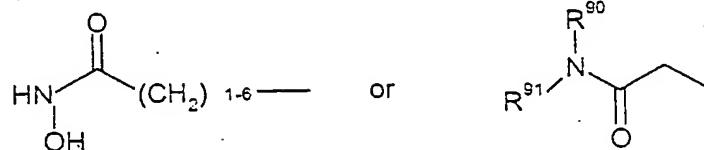
WO 00/75106 discloses the compounds represented by the general formula:

- 6 -



wherein

Z represents



5

in which

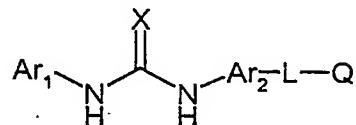
10  $\text{R}^{90}$  is hydrogen,  $\text{C}_{1-12}$  alkyl,  $\text{C}_{3-8}$  cycloalkyl, or the like, and  $\text{R}^{91}$  is amino- $\text{C}_{1-6}$  alkyl, aminocarbonyl- $\text{C}_{1-6}$  alkyl, or hydroxyamino-carbonyl  $\text{C}_{1-6}$  alkyl; and

15

$\text{R}^{90}$  and  $\text{R}^{91}$  are independently selected from the group consisting of H,  $\text{C}_{1-6}$  alkyl,  $\text{C}_{1-6}$  alkylthio,  $\text{C}_{1-6}$  alkoxy, fluoro, chloro, bromo, iodo, and nitro;

as useful agents for treating MMP-mediated diseases in mammals.

WO 00/55152 discloses the compounds represented by the general formula:



5       wherein

Ar<sub>1</sub>    is heterocycle;

Ar<sub>2</sub>    is tetrahydronaphthy; and

10       L and Q are defined in this specification;

as useful agents for treating inflammation, immune related disease, pain and diabetes.

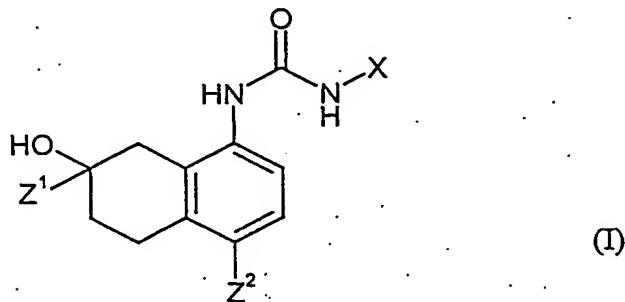
15       However, none of these reference discloses simple hydroxy-tetrahydro-naphthalenyl-urea derivatives having VR1 antagonistic activity.

20       The development of a compound which has effective VR1 antagonistic activity and can be used for the prophylaxis and treatment of diseases associated with VR1 activity, in particular for the treatment of urinary incontinence, urge urinary incontinence, overactive bladder as well as pain, and/or inflammatory diseases such as asthma and COPD has been desired.

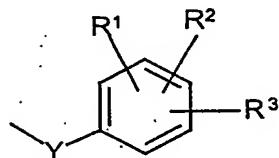
SUMMARY OF THE INVENTION

This invention is to provide a hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), their tautomeric and stereoisomeric form, and salts thereof:

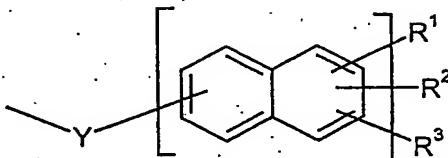
5



wherein



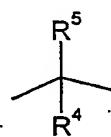
or



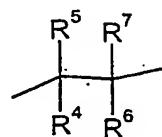
10

in which

Y represents a direct bond,



or



15

R<sup>1</sup>, R<sup>2</sup> and R<sup>3</sup> independently represent hydrogen, halogen, hydroxy, nitro, carboxy, amino, C<sub>1-6</sub> alkylamino, di(C<sub>1-6</sub> alkyl)amino, C<sub>3-8</sub> cycloalkylamino, C<sub>1-6</sub> alkoxy carbonyl, phenyl, benzyl, sulfonamide, C<sub>1-6</sub> alkanoyl, C<sub>1-6</sub> alkanoyl amine, carbamoyl,

20

5                   C<sub>1-6</sub> alkylcarbamoyl, cyano, C<sub>1-6</sub> alkyl optionally substituted by cyano, C<sub>1-6</sub> alkoxycarbonyl or mono-, di-, or tri-halogen, C<sub>1-6</sub> alkoxy optionally substituted by mono-, di-, or tri- halogen, phenoxy optionally substituted by halogen or C<sub>1-6</sub> alkyl, or C<sub>1-6</sub> alkylthio optionally substituted by mono-, di-, or tri- halogen;

10                  R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup> and R<sup>7</sup> independently represent hydrogen, C<sub>1-6</sub> alkyl or phenyl;

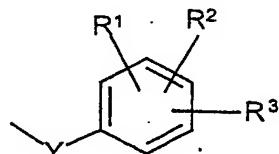
15                  Z<sup>1</sup>    represents hydrogen or C<sub>1-6</sub> alkyl; and

20                  Z<sup>2</sup>    represents hydrogen, halogen or C<sub>1-6</sub> alkyl.

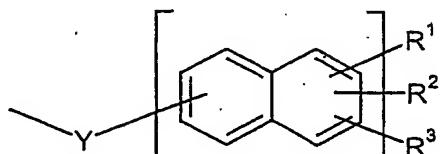
15                  The hydroxy-tetrahydro-naphthalenylurea derivatives of formula (I), their tautomeric and stereoisomeric form, and salts thereof surprisingly show excellent VR1 antagonistic activity. They are, therefore suitable especially for the prophylaxis and treatment of diseases associated with VR1 activity, in particular for the treatment of urge urinary incontinence and/or overactive bladder.

20                  Preferably, the hydroxy-tetrahydro-naphthalenylurea derivatives of formula (I) are those wherein

                  X    represents



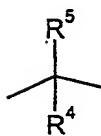
                  or



                  in which

                  Y    represents a direct bond, or

- 10 -



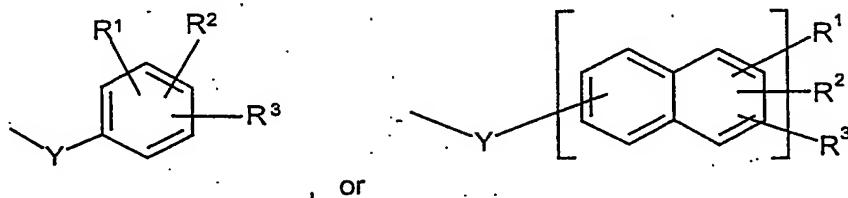
5                     $R^1$ ,  $R^2$  and  $R^3$  independently represent hydrogen, halogen, hydroxy, nitro, carboxyl, amino,  $C_{1-6}$  alkylamino, di( $C_{1-6}$  alkyl)amino,  $C_{3-8}$  cycloalkylamino,  $C_{1-6}$  alkoxycarbonyl, phenyl, benzyl, sulfonamide,  $C_{1-6}$  alkanoyl,  $C_{1-6}$  alkanoylamino, carbamoyl,  $C_{1-6}$  alkylcarbamoyl, cyano,  $C_{1-6}$  alkyl optionally substituted by cyano,  $C_{1-6}$  alkoxycarbonyl or mono-, di-, or tri-halogen,  $C_{1-6}$  alkoxy optionally substituted by mono-, di-, or tri- halogen, phenoxy optionally substituted by halogen or  $C_{1-6}$  alkyl, or  $C_{1-6}$  alkylthio optionally substituted by mono-, di-, or tri- halogen;

10                     $R^4$  and  $R^5$  independently represent hydrogen or  $C_{1-6}$  alkyl; and

15                     $Z^1$  and  $Z^2$  each represent hydrogen.

In another embodiment, the hydroxy-tetrahydro-naphthalenylurea derivatives of formula (I) can be those wherein

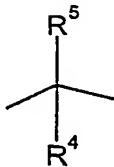
20                    X                    represents



25                    in which

- 11 -

Y represents a direct bond or



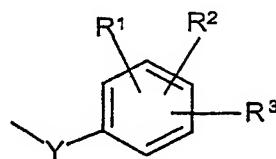
5 R<sup>1</sup>, R<sup>2</sup> and R<sup>3</sup> independently represent hydrogen, halogen, di(C<sub>1-6</sub> alkyl)amino, C<sub>3-8</sub> cycloalkylamino, C<sub>1-6</sub> alkoxycarbonyl, C<sub>1-6</sub> alkyl optionally substituted by cyano, C<sub>1-6</sub> alkoxycarbonyl or mono-, di-, or tri-halogen, C<sub>1-6</sub> alkoxy optionally substituted by mono-, di-, or tri- halogen, phenoxy optionally substituted by halogen or C<sub>1-6</sub> alkyl, or C<sub>1-6</sub> alkylthio optionally substituted by mono-, di-, or tri- halogen;

10

R<sup>4</sup> and R<sup>5</sup> each represent hydrogen; and15 Z<sup>1</sup> and Z<sup>2</sup> each represent hydrogen.

In another embodiment, the hydroxy-tetrahydro-naphthalenylurea derivatives of formula (I) can be those wherein

20 X represents

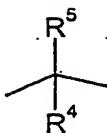


in which

25

Y represents a direct bond or

- 12 -



in which

5

$R^1$  and  $R^2$  independently represent hydrogen, chloro, bromo, fluoro, cyclopentylamino, trifluoromethyl, or trifluoromethoxy;

10

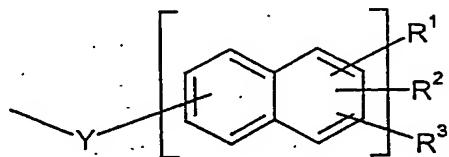
$R^3$ ,  $R^4$  and  $R^5$  each represent hydrogen; and

$Z^1$  and  $Z^2$  each represent hydrogen.

In another embodiment, the hydroxy-tetrahydro-naphthalenylurea derivatives of formula (I) can be those wherein

15

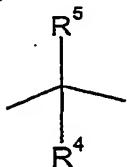
$X$  represents



in which

20

$Y$  represents direct bond or



in which

5           R<sup>1</sup> and R<sup>2</sup> independently represent hydrogen, chloro, bromo, fluoro, cyclopentylamino, trifluoromethyl, or trifluoromethoxy;

R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> each represent hydrogen; and

10           Z<sup>1</sup> and Z<sup>2</sup> each represent hydrogen.

More preferably, said hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I) is selected from the group consisting of:

15           N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
N-(3-chlorophenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[3-(trifluoromethyl)phenyl]urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[4-(trifluoromethyl)phenyl]urea;  
Ethyl 3-({[(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)amino]carbonyl}amino)benzoate;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(1-naphthyl)urea;  
20           N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(2-naphthyl)urea;  
N-(3,4-dichlorophenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(4-isopropylphenyl)urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(4-phenoxyphenyl)urea.  
N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-  
25           naphthalenyl)urea;  
N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-[<sup>7S</sup>-(7S)-7-hydroxy-5,6,7,8-tetrahydro-1-  
naphthalenyl]urea;  
N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-[<sup>7R</sup>-(7R)-7-hydroxy-5,6,7,8-tetrahydro-1-  
naphthalenyl]urea;  
30           N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-phenylurea;  
N-(4-chlorophenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;

N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(2-(trifluoromethyl)phenyl]urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(4-(trifluoromethyl)phenyl]urea;  
N-(3,4-dichlorophenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(4-(trifluoromethoxy)phenyl]urea;  
5 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(4-(trifluoromethoxy)benzyl]urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(2,4,6-trimethoxybenzyl)urea;  
N-(2,6-difluorobenzyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
N-[(7R)-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-(4-(trifluoromethyl)benzyl]urea;  
N-[(7S)-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-(4-(trifluoromethyl)-  
10 benzyl]urea;  
N-[(7R)-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-(4-(trifluoromethoxy)-  
benzyl]urea;  
N-[(7S)-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-(4-(trifluoromethoxy)-  
benzyl]urea;  
15 N-[2-(4-chlorophenyl)ethyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
and  
N-[3-fluoro-4-(trifluoromethyl)benzyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-  
naphthalenyl)urea.

20 In the context of the present invention, the substituents, if not stated otherwise, in  
general have the following meaning:

The Alkyl per se and "alk" and "alkyl" in alkoxy, alkanoyl, alkylamino, alkylamino-  
carbonyl, alkylaminosulphonyl, alkylsulphonylamino, alkoxy carbonyl, alkoxy-  
25 carbonylamino and alkanoylamino represent a linear or branched alkyl radical having  
generally 1 to 6, preferably 1 to 4 and particularly preferably 1 to 3 carbon atoms,  
representing illustratively and preferably methyl, ethyl, n-propyl, isopropyl, tert-  
butyl, n-pentyl and n-hexyl.

30 Alkoxy illustratively and preferably represents methoxy, ethoxy, n-propoxy, iso-  
propoxy, tert-butoxy, n-pentoxyl and n-hexoxy.

Alkanoyl illustratively and preferably represents acetyl and propanoyl.

Alkylamino represents an alkylamino radical having one or two (independently selected) alkyl substituents, illustratively and preferably representing methylamino, ethylamino, n-propylamino, isopropylamino, tert-butylamino, n-pentylamino, n-hexyl-amino, N,N-dimethylamino, N,N-diethylamino, N-ethyl-N-methylamino, N-methyl-N-n-propylamino, N-isopropyl-N-n-propylamino, N-t-butyl-N-methylamino, N-ethyl-N-n-pentylamino and N-n-hexyl-N-methylamino.

10

Alkylaminocarbonyl or alkylcarbamoyl represents an alkylaminocarbonyl radical having one or two (independently selected) alkyl substituents, illustratively and preferably representing methylaminocarbonyl, ethylaminocarbonyl, n-propylaminocarbonyl, isopropylamino-carbonyl, tert-butylaminocarbonyl, n-pentylaminocarbonyl, n-hexylaminocarbonyl, N,N-dimethylaminocarbonyl, N,N-diethylaminocarbonyl, N-ethyl-N-methylaminocarbonyl, N-methyl-N-n-propylaminocarbonyl, N-isopropyl-N-n-propylaminocarbonyl, N-t-butyl-N-methylaminocarbonyl, N-ethyl-N-n-pentylamino-carbonyl and N-n-hexyl-N-methylaminocarbonyl.

20

Alkoxycarbonyl illustratively and preferably represents methoxycarbonyl, ethoxy-carbonyl, n-propoxycarbonyl, isopropoxycarbonyl, tert-butoxycarbonyl, n-pentoxy-carbonyl and n-hexaoxycarbonyl. Alkoxycarbonylamino illustratively and preferably represents methoxycarbonylamino, ethoxycarbonylamino, n-propoxycarbonylamino, isopropoxycarbonylamino, tert-butoxycarbonylamino, n-pentoxy carbonylamino and n-hexaoxycarbonylamino.

Alkanoylamino illustratively and preferably represents acetylamino and ethylcarbamylamino.

30

Cycloalkyl per se and in cycloalkylamino and in cycloalkylcarbonyl represents a cycloalkyl group having generally 3 to 8 and preferably 5 to 7 carbon atoms,

illustratively and preferably representing cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl and cycloheptyl.

5 Cycloalkylamino represents a cycloalkylamino radical having one or two (independently selected) cycloalkyl substituents, illustratively and preferably representing cyclopropylamino, cyclobutylamino, cyclopentylamino, cyclohexylamino and cycloheptylamino.

Halogen represents fluorine, chlorine, bromine and iodine.

10

Preferably, the medicament of the present invention further comprise one or more pharmaceutically acceptable carriers and/or excipients.

The hydroxy-tetrahydro-naphthalenylurea derivatives of the formula (I), their tautomeric and stereoisomeric form, and salts thereof are effective for treating or preventing a disease selected from the group consisting of urge urinary incontinence, overactive bladder, chronic pain, neuropathic pain, postoperative pain, rheumatoid arthritic pain, neuralgia, neuropathies, algesia, nerve injury, ischaemia, neurodegeneration and/or stroke, as well as inflammatory diseases such as asthma and COPD since the diseases also relate to VR1 activity.

20

The compounds are additionally of use for the treatment and prophylaxis of Neuropathic pain, is a form of pain often associated with herpes zoster and post-herpetic neuralgia, painful diabetic neuropathy, neuropathic low back pain, posttraumatic and postoperative neuralgia, neuralgia due to nerve compression and other neuralgias, phantom pain, complex regional pain syndromes, infectious or parainfectious neuropathies like those associated with HIV infection, pain associated with central nervous system disorders like multiple sclerosis or Parkinson disease or spinal cord injury or traumatic brain injury, and post-stroke pain.

30

Furthermore, the compounds are useful for the treatment of musculoskeletal pain, a form of pain often associated with osteoarthritis or rheumatoid arthritis or other forms of arthritis, and back pain.

5 In addition, the compounds are useful for the treatment of pain associated with cancer, including visceral or neuropathic pain associated with cancer or cancer treatment.

10 The compounds are furthermore useful for the treatment of visceral pain, e.g. pain associated with obstruction of hollow viscera like gallstone colic, pain associated with irritable bowel syndrome, pelvic pain, vulvodynia, orchialgia or prostatodynia.

The compounds are also useful for the treatment of pain associated with inflammatory lesions of joints, skin, muscles or nerves.

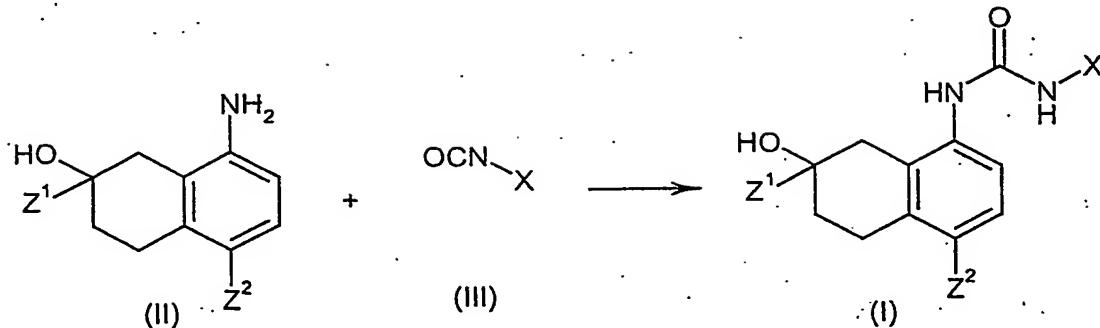
15 The compounds are of use for the treatment of orofascial pain and headache, e.g. migraine or tension-type headache.

#### EMBODIMENT OF THE INVENTION

20 The compound of the formula (I) of the present invention can be, but not limited to be, prepared by the methods [A], [B], [C], [D], [E], [F], or [G] below. In some embodiments, one or more of the substituents, such as amino group, carboxyl group, and hydroxyl group of the compounds used as starting materials or intermediates are advantageously protected by a protecting group known to those skilled in the art.

25 Examples of the protecting groups are described in "Protective Groups in Organic Synthesis (3rd Edition)" by Greene and Wuts, John Wiley and Sons, New York 1999.

### Method A



5. The compound of the formula (I) (wherein X, Z<sup>1</sup> and Z<sup>2</sup> are the same as defined above) can be prepared by the reaction of the compound of the formula (II) (wherein Z<sup>1</sup> and Z<sup>2</sup> are the same as defined above) and isocyanate (III) (wherein X is the same as defined above).

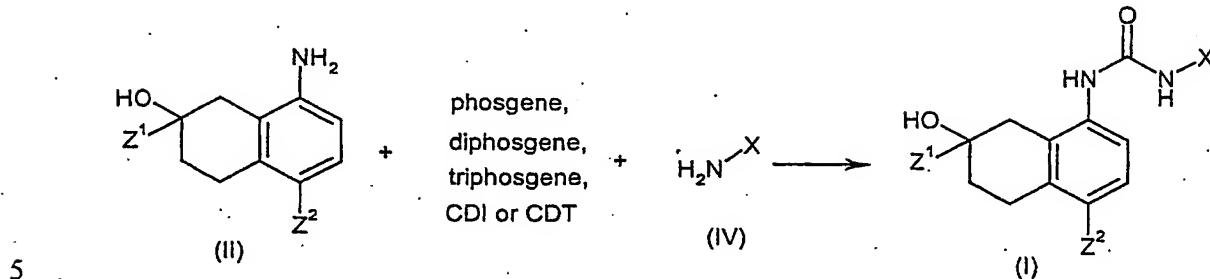
The reaction may be carried out in a solvent including, for instance, halogenated hydrocarbons such as dichloromethane, chloroform and 1,2-dichloroethane; ethers such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-dimethoxyethane; aromatic hydrocarbons such as benzene, toluene and xylene; nitriles such as acetonitrile; amides such as N, N-dimethylformamide (DMF), N, N-dimethylacetamide (DMAC) and N-methylpyrrolidone (NMP); urea such as 1,3-dimethyl-2-imidazolidinone (DMI); sulfoxides such as dimethylsulfoxide (DMSO); and others. Optionally, two or more of the solvents selected from the listed above can be mixed and used.

The reaction can be carried out in the presence of organic base such as pyridine or triethylamine.

The reaction temperature can be optionally set depending on the compounds to be reacted. The reaction temperature is usually, but not limited to, about room temperature to 100°C. The reaction may be conducted for, usually, 30 minutes to 48 hours and preferably 1 to 24 hours.

The compound of the formula (II) and isocyanate (III) are commercially available or can be prepared by the use of known techniques.

[Method B]



The compound of the formula (I) (wherein X, Z<sup>1</sup> and Z<sup>2</sup> are the same as defined above) can be prepared by reacting the compound of the formula (II) (wherein Z<sup>1</sup> and Z<sup>2</sup> are the same as defined above) with phosgene, diphosgene, triphosgene, 1,1-carbonyldiimidazole (CDI), or 1,1'-carbonyldi(1,2,4-triazole)(CDT), and then adding the compound of the formula (IV) (wherein X is the same as defined above) to the reaction mixture:

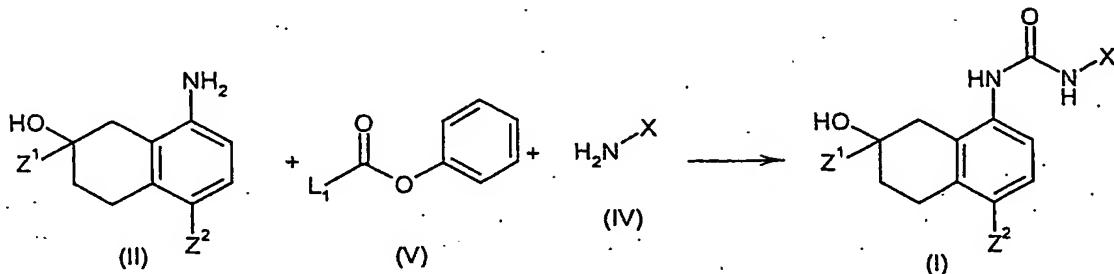
The reaction may be carried out in a solvent including, for instance, halogenated hydrocarbons such as dichloromethane, chloroform and 1,2-dichloroethane; ethers such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-dimethoxyethane; aromatic hydrocarbons such as benzene, toluene and xylene; nitriles such as acetonitrile; amides such as N, N-dimethylformamide (DMF), N, N-dimethylacetamide (DMAC) and N-methylpyrrolidone (NMP); urea such as 1,3-dimethyl-2-imidazolidinone (DMI); and others. Optionally, two or more of the solvents selected from the listed above can be mixed and used.

The reaction temperature can be optionally set depending on the compounds to be reacted. The reaction temperature is usually, but not limited to, about 20°C to 50°C. The reaction may be conducted for, usually, 30 minutes to 10 hours and preferably 1 to 24 hours.

Phosgene, diphosgene, triphosgene, CDI, and CDT are commercially available and the compound of the formula (IV) is commercially available or can be prepared by the use of known techniques.

5

### [Method C]



10 The compound of the formula (I) (wherein X,  $Z^1$  and  $Z^2$  are the same as defined above) can be prepared by reacting the compound of the formula (II) (wherein  $Z^1$  and  $Z^2$  are the same as defined above) and the compound of the formula (V) (wherein  $L_1$  represents halogen atom such as chlorine, bromine, or iodine atom) and then adding the compound of the formula (IV) (wherein X is the same as defined above) to the reaction mixture.

15

The reaction may be carried out in a solvent including, for instance, halogenated hydrocarbons such as dichloromethane, chloroform and 1,2-dichloroethane; ethers such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-dimethoxyethane; aromatic hydrocarbons such as benzene, toluene and xylene; nitriles such as acetonitrile; amides such as N, N-dimethylformamide (DMF), N, N-dimethylacetamide (DMAC) and N-methylpyrrolidone (NMP); urea such as 1,3-dimethyl-2-imidazolidinone (DMI); and others. Optionally, two or more of the solvents selected from the listed above can be mixed and used.

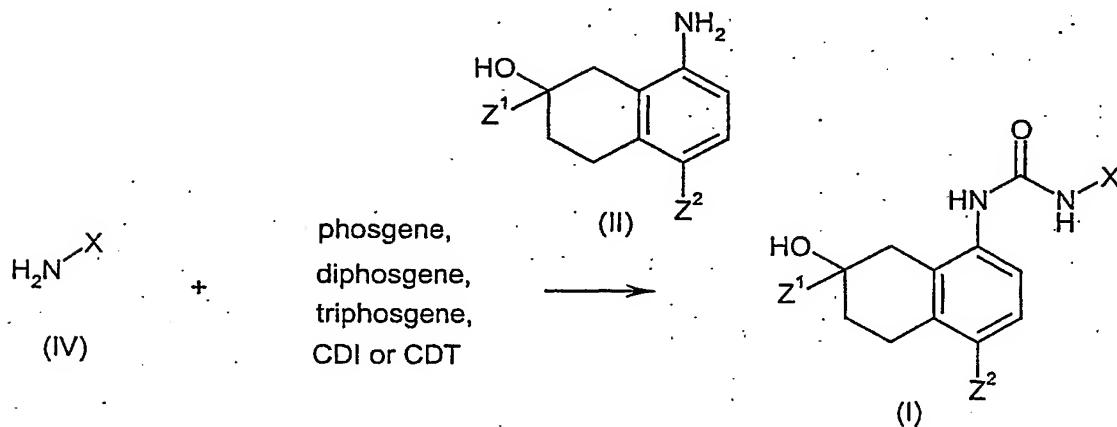
25 The reaction temperature can be optionally set depending on the compounds to be reacted. The reaction temperature is usually, but not limited to, about 30°C to 120°C.

The reaction may be conducted for, usually, 1 hour to 48 hours and preferably 2 to 24 hours.

5 The reaction can be advantageously carried out in the presence of a base including, for instance, organic amines such as pyridine, triethylamine and N,N-diisopropylethylamine, dimethylaniline, diethylaniline, 4-dimethylaminopyridine, and others.

10 The compound (V) is commercially available or can be prepared by the use of known techniques.

[Method D]



15. The compound of the formula (I) (wherein X,  $Z^1$  and  $Z^2$  are the same as defined above) can be prepared by reacting the compound of the formula (IV) (wherein X is the same as defined above) with phosgene, diphosgene, triphosgene, 1,1-carbonyldiimidazole (CDI), or 1,1'-carbonyldi(1,2,4-triazole)(CDT), and then adding the compound of the formula (II) (wherein  $Z^1$  and  $Z^2$  are the same as defined above) to 20 the reaction mixture.

The reaction may be carried out in a solvent including, for instance, halogenated hydrocarbons such as dichloromethane, chloroform and 1,2-dichloroethane; ethers such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-

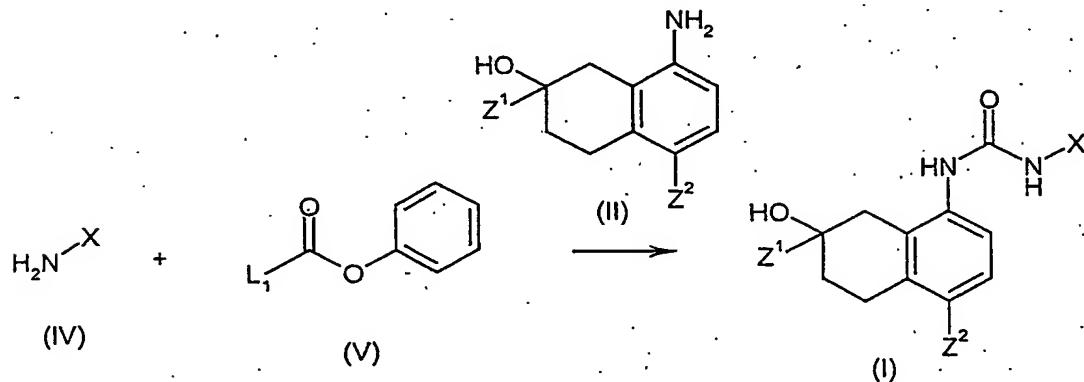
dimethoxyethane; aromatic hydrocarbons such as benzene, toluene and xylene; nitriles such as acetonitrile; amides such as N, N-dimethylformamide (DMF), N, N-dimethylacetamide (DMAc) and N-methylpyrrolidone (NMP); urea such as 1,3-dimethyl-2-imidazolidinone (DMI); sulfoxides such as dimethylsulfoxide (DMSO); and others. Optionally, two or more of the solvents selected from the listed above can be mixed and used.

The reaction temperature can be optionally set depending on the compounds to be reacted. The reaction temperature is usually, but not limited to, about 30°C to 100°C.

10

The reaction may be conducted for, usually, 30 minutes to 40 hours and preferably 1 to 24 hours.

[Method E]



15

The compound of the formula (I) (wherein  $\text{X}$ ,  $\text{Z}^1$  and  $\text{Z}^2$  are the same as defined above) can be prepared by reacting the compound of the formula (IV) (wherein  $\text{X}$  is the same as defined above) and the compound of the formula (V) (wherein  $\text{L}_1$  represents halogen atom such as chlorine, bromine, or iodine atom) and then adding the compound of the formula (II) (wherein  $\text{Z}^1$  and  $\text{Z}^2$  are the same as defined above) to the reaction mixture.

The reaction may be carried out in a solvent including, for instance, halogenated hydrocarbons such as dichloromethane, chloroform and 1,2-dichloroethane; ethers

such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-dimethoxyethane; aromatic hydrocarbons such as benzene, toluene and xylene; nitriles such as acetonitrile; amides such as N, N-dimethylformamide (DMF), N, N-dimethylacetamide (DMAC) and N-methylpyrrolidone (NMP); urea such as 1,3-dimethyl-2-imidazolidinone (DMI); and others. Optionally, two or more of the solvents selected from the listed above can be mixed and used.

The reaction temperature can be optionally set depending on the compounds to be reacted. The reaction temperature is usually, but not limited to, about 30°C to 120°C.

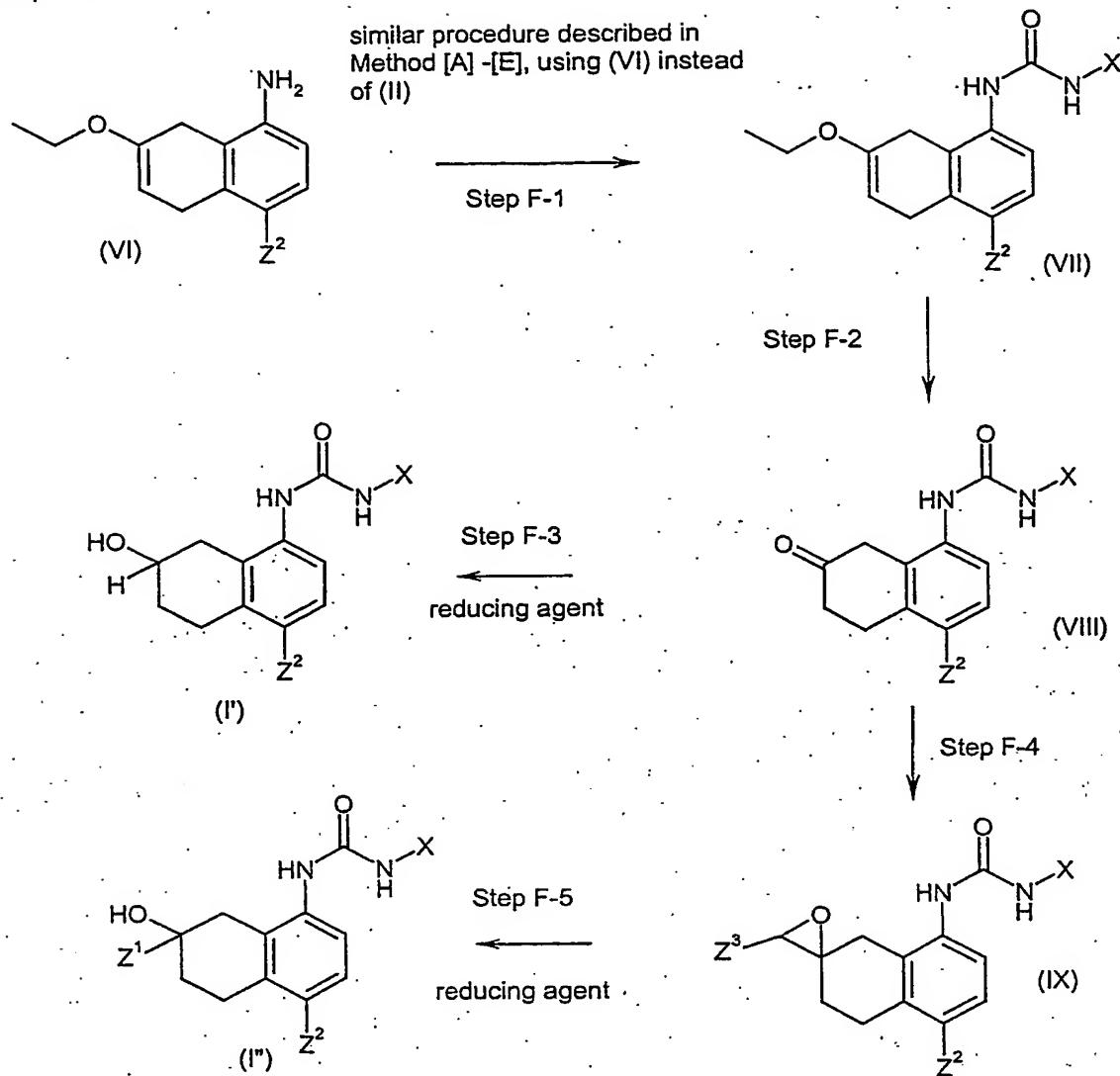
10

The reaction may be conducted for, usually, 1 hour to 48 hours and preferably 2 to 24 hours.

15

The reaction can be advantageously carried out in the presence of a base including, for instance, organic amines such as pyridine, triethylamine and N,N-diisopropylethylamine, dimethylaniline, diethylaniline, 4-dimethylaminopyridine, and others.

## [Method F]



The compound of the formula (I') (wherein X and Z<sup>2</sup> are the same as defined above) can be prepared by the following procedures;

In the Step F-1, the compound of the formula (VII) (wherein X and Z<sup>2</sup> are the same as defined above) can be prepared in the similar manner as described in Method [A], [B], [C], [D], or [E] for the preparation of the compound of the formula (I) by using a compound of the formula (VI) (wherein Z<sup>2</sup> is the same as defined above) instead of the compound of the formula (II).

In the Step F-2, the compound of the formula (VIII) (wherein X and Z<sup>2</sup> are the same as defined above) can be prepared by reacting the compound of the formula (VII) (wherein X and Z<sup>2</sup> are the same as defined above) with an acid such as hydrochloric acid.

5

The reaction may be carried out in a solvent including, for instance, halogenated hydrocarbons such as dichloromethane, chloroform and 1,2-dichloroethane; ethers such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-dimethoxyethane; alcohols such as methanol, ethanol; water and others. Optionally,

10 two or more of the solvents selected from the listed above can be mixed and used.

The reaction temperature can be optionally set depending on the compounds to be reacted. The reaction temperature is usually, but not limited to, about 20°C to 100°C.

The reaction may be conducted for, usually, 30 minutes to 10 hours and preferably 1

15 to 24 hours.

In the Step F-3, the compound of the formula (I') (wherein X and Z<sup>2</sup> are the same as defined above) can be prepared by reacting the compound of the formula (VIII)

(wherein X and Z<sup>2</sup> are the same as defined above) with reducing agent such as 20 sodium borohydride or lithium aluminum hydride.

The reaction may be carried out in a solvent including, for instance, ethers such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-di-

25 methoxyethane; aliphatic hydrocarbons such as n-hexane, cyclohexane; aromatic hydrocarbons such as benzene, toluene and xylene; alcohols such as methanol, ethanol, isopropanol, and others. Optionally, two or more of the solvents selected

from the listed above can be mixed and used.

The reaction temperature can be optionally set depending on the compounds to be 30 reacted. The reaction temperature is usually, but not limited to, about -20°C to 50°C.

The reaction may be conducted for, usually, 30 minutes to 10 hours and preferably 1 to 24 hours.

5 The compound of the formula (I") (wherein X and Z<sup>2</sup> are the same as defined above and Z<sup>1</sup> is C<sub>1-6</sub> alkyl) can be prepared by the following procedures in two steps.

In the Step F-4, the compound of the formula (IX) (wherein X and Z<sup>2</sup> are the same as defined above and Z<sup>3</sup> is hydrogen or C<sub>1-5</sub> alkyl) can be prepared by reacting the compound of the formula (VIII) (wherein X and Z<sup>2</sup> are the same as defined above) 10 with tri(C<sub>1-6</sub> alkyl)oxosulfonium salt such as trimethyloxosulfonium iodide.

15 The reaction may be carried out in a solvent including, for instance, ethers such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-dimethoxyethane; aliphatic hydrocarbons such as n-hexane, cyclohexane; aromatic hydrocarbons such as benzene, toluene and xylene; and others. Optionally, two or 20 more of the solvents selected from the listed above can be mixed and used.

The reaction temperature can be optionally set depending on the compounds to be reacted. The reaction temperature is usually, but not limited to, about -20°C to 50°C. 20 The reaction may be conducted for, usually, 30 minutes to 10 hours and preferably 1 to 24 hours.

25 In the Step F-5, the compound of the formula (I") (wherein X, Z<sup>2</sup> are the same as defined above and Z<sup>1</sup> is C<sub>1-6</sub> alkyl) can be prepared by reacting the compound of the formula (IX) (wherein X and Z<sup>2</sup> are the same as defined above and Z<sup>3</sup> is hydrogen or C<sub>1-5</sub> alkyl) with reducing agent such as sodium borohydride or lithium aluminum hydride.

30 The reaction may be carried out in a solvent including, for instance, ethers such as diethyl ether, isopropyl ether, dioxane and tetrahydrofuran (THF) and 1,2-dimethoxyethane; aliphatic hydrocarbons such as n-hexane, cyclohexane; aromatic

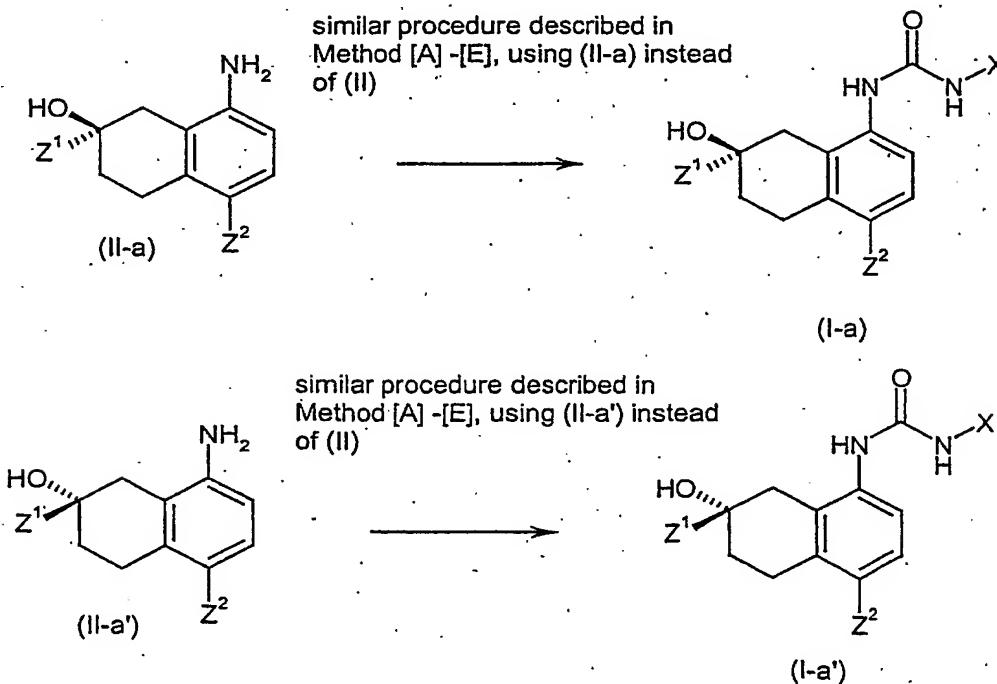
hydrocarbons such as benzene, toluene and xylene; and others. Optionally, two or more of the solvents selected from the listed above can be mixed and used.

5 The reaction temperature can be optionally set depending on the compounds to be reacted. The reaction temperature is usually, but not limited to, about 20°C to 50°C.

The reaction may be conducted for, usually, 30 minutes to 10 hours and preferably 1 to 24 hours.

10 The compound (VI) is commercially available or can be prepared by the use of known techniques.

**[Method G]**



15 The stereoisomeric form of the compound (I), R form (I-a) R form (I-a') (wherein X, Z<sup>1</sup> and Z<sup>2</sup> are the same as defined above) can be prepared in the similar manner as described in Method [A], [B], [C], [D], or [E] for the preparation of the compound of the formula (I) by using a compound of the formula (II-a) (wherein Z<sup>1</sup> and Z<sup>2</sup> are the same as defined above) instead of the compound of the formula (II).

The stereoisomeric form of the compound (I), S form (I-a') (wherein X, Z<sup>1</sup> and Z<sup>2</sup> are the same as defined above) can be prepared in the similar manner as described in Method [A], [B], [C], [D], or [E] for the preparation of the compound of the formula 5 (I) by using a compound of the formula (II-a') (wherein Z<sup>1</sup> and Z<sup>2</sup> are the same as defined above) instead of the compound of the formula (II).

The compound (II-a) or (II-a') can be prepared by the use of known techniques.

10 When the compound shown by the formula (I) or a salt thereof has an asymmetric carbon in the structure, their optically active compounds and racemic mixtures are also included in the scope of the present invention.

15 Typical salts of the compound shown by the formula (I) include salts prepared by reaction of the compounds of the present invention with a mineral or organic acid, or an organic or inorganic base. Such salts are known as acid addition and base addition salts, respectively.

20 Acids to form acid addition salts include inorganic acids such as, without limitation, sulfuric acid, phosphoric acid, hydrochloric acid, hydrobromic acid, hydriodic acid and the like, and organic acids, such as, without limitation, p-toluenesulfonic acid, methanesulfonic acid, oxalic acid, p-bromophenylsulfonic acid, carbonic acid, succinic acid, citric acid, benzoic acid, acetic acid, and the like.

25 Base addition salts include those derived from inorganic bases, such as, without limitation, ammonium hydroxide, alkaline metal hydroxide, alkaline earth metal hydroxides, carbonates, bicarbonates, and the like, and organic bases, such as, without limitation, ethanolamine, triethylamine, tris(hydroxymethyl)aminomethane, and the like. Examples of inorganic bases include sodium hydroxide, potassium hydroxide, potassium carbonate, sodium carbonate, sodium bicarbonate, potassium bicarbonate, calcium hydroxide, calcium carbonate, and the like.

5 The compound of the present invention or a salt thereof, depending on its substituents, may be modified to form lower alkylesters or known other esters; and/or hydrates or other solvates. Those esters, hydrates, and solvates are included in the scope of the present invention.

10 The compound of the present invention may be administered in oral forms, such as, without limitation normal and enteric coated tablets, capsules, pills, powders, granules, elixirs, tinctures, solution, suspensions, syrups, solid and liquid aerosols and emulsions. They may also be administered in parenteral forms, such as, without limitation, intravenous, intraperitoneal, subcutaneous, intramuscular, and the like forms, well-known to those of ordinary skill in the pharmaceutical arts. The compounds of the present invention can be administered in intranasal form via topical use of suitable intranasal vehicles, or via transdermal routes, using 15 transdermal delivery systems well-known to those of ordinary skilled in the art.

20 The dosage regimen with the use of the compounds of the present invention is selected by one of ordinary skill in the arts, in view of a variety of factors, including, without limitation, age, weight, sex, and medical condition of the recipient, the severity of the condition to be treated, the route of administration, the level of metabolic and excretory function of the recipient, the dosage form employed, the particular compound and salt thereof employed.

25 The compounds of the present invention are preferably formulated prior to administration together with one or more pharmaceutically-acceptable excipients. Excipients are inert substances such as, without limitation carriers, diluents, flavoring agents, sweeteners, lubricants, solubilizers, suspending agents, binders, tablet disintegrating agents and encapsulating material.

30 Yet another embodiment of the present invention is pharmaceutical formulation comprising a compound of the invention and one or more pharmaceutically-

acceptable excipients that are compatible with the other ingredients of the formulation and not deleterious to the recipient thereof. Pharmaceutical formulations of the invention are prepared by combining a therapeutically effective amount of the compounds of the invention together with one or more pharmaceutically-acceptable excipients therefore. In making the compositions of the present invention, the active ingredient may be mixed with a diluent, or enclosed within a carrier, which may be in the form of a capsule, sachet, paper, or other container. The carrier may serve as a diluent, which may be solid, semi-solid, or liquid material which acts as a vehicle, or can be in the form of tablets, pills, powders, lozenges, elixirs, suspensions, emulsions, 10 solutions, syrups, aerosols, ointments, containing, for example, up to 10% by weight of the active compound, soft and hard gelatin capsules, suppositories, sterile injectable solutions and sterile packaged powders.

For oral administration, the active ingredient may be combined with an oral, and 15 non-toxic, pharmaceutically-acceptable carrier, such as, without limitation, lactose, starch, sucrose, glucose, sodium carbonate, mannitol, sorbitol, calcium carbonate, calcium phosphate, calcium sulfate, methyl cellulose, and the like; together with, optionally, disintegrating agents, such as, without limitation, maize, starch, methyl cellulose, agar bentonite, xanthan gum, alginic acid, and the like; and optionally, 20 binding agents, for example, without limitation, gelatin, natural sugars, beta-lactose, corn sweeteners, natural and synthetic gums, acacia, tragacanth, sodium alginate, carboxymethylcellulose, polyethylene glycol, waxes, and the like; and, optionally, lubricating agents, for example, without limitation, magnesium stearate, sodium stearate, stearic acid, sodium oleate, sodium benzoate, sodium acetate, sodium 25 chloride, talc, and the like.

In powder forms, the carrier may be a finely divided solid which is in admixture with the finely divided active ingredient. The active ingredient may be mixed with a carrier having binding properties in suitable proportions and compacted in the shape 30 and size desired to produce tablets. The powders and tablets preferably contain from about 1 to about 99 weight percent of the active ingredient which is the novel

composition of the present invention. Suitable solid carriers are magnesium carboxymethyl cellulose, low melting waxes, and cocoa butter.

5 Sterile liquid formulations include suspensions, emulsions, syrups and elixirs. The active ingredient can be dissolved or suspended in a pharmaceutically acceptable carriers, such as sterile water, sterile organic solvent, or a mixture of both sterile water and sterile organic solvent.

10 The active ingredient can also be dissolved in a suitable organic solvent, for example, aqueous propylene glycol. Other compositions can be made by dispersing the finely divided active ingredient in aqueous starch or sodium carboxymethyl cellulose solution or in a suitable oil.

15 The formulation may be in unit dosage form, which is a physically discrete unit containing a unit dose, suitable for administration in human or other mammals. A unit dosage form can be a capsule or tablets, or a number of capsules or tablets. A "unit dose" is a predetermined quantity of the active compound of the present invention, calculated to produce the desired therapeutic effect, in association with one or more excipients. The quantity of active ingredient in a unit dose may be 20 varied or adjusted from about 0.1 to about 1000 milligrams or more according to the particular treatment involved.

25 Typical oral dosages of the present invention, when used for the indicated effects, will range from about 0.01mg /kg/day to about 100 mg/kg/day, preferably from 0.1 mg/kg/day to 30 mg/kg/day, and most preferably from about 0.5 mg/kg/day to about 10 mg/kg/day. In the case of parenteral administration, it has generally proven advantageous to administer quantities of about 0.001 to 100mg /kg/day, preferably from 0.01 mg/kg/day to 1 mg/kg/day. The compounds of the present invention may be administered in a single daily dose, or the total daily dose may be administered in 30 divided doses, two, three, or more times per day. Where delivery is via transdermal forms, of course, administration is continuous.

EXAMPLES

The present invention will be described as a form of examples, but they should by no means be construed as defining the metes and bounds of the present invention.

5

In the examples below, all quantitative data, if not stated otherwise, relate to percentages by weight.

Mass spectra were obtained using electrospray (ES) ionization techniques  
10 (micromass Platform LC). Melting points are uncorrected. Liquid Chromatography  
- Mass spectroscopy (LC-MS) data were recorded on a Micromass Platform LC with  
Shimadzu Phenomenex ODS column(4.6 mmφ X 30 mm) flushing a mixture of  
acetonitrile-water (9:1 to 1:9) at 1 ml/min of the flow rate. TLC was performed on a  
precoated silica gel plate (Merck silica gel 60 F-254). Silica gel (WAKO-gel C-200  
15 (75-150 µm)) was used for all column chromatography separations. All chemicals  
were reagent grade and were purchased from Sigma-Aldrich, Wako pure chemical  
industries, Ltd., Tokyo kasei kogyo co. Ltd., Arch corporation.

20 All starting materials are commercially available or can be prepared using methods  
cited in the literature.

The effect of the present compounds were examined by the following assays and  
pharmacological tests.

25 [Measurement of capsaicin-induced  $\text{Ca}^{2+}$  influx in the human VR1-transfected CHO  
cell line] (Assay 1)

(1) Establishment of the human VR1-CHOLuc9aeq cell line

30 Human vanilloid receptor (hVR1) cDNA was cloned from libraries of  
axotomized dorsal root ganglia (WO 00/29577). The cloned hVR1 cDNA was

constructed with pcDNA3 vector and transfected into a CHO<sub>luc9aeq</sub> cell line. The cell line contains aequorin and CRE-luciferase reporter genes as read-out signals. The transfectants were cloned by limiting dilution in selection medium (DMEM/F12 medium (Gibco BRL) supplemented with 10% FCS, 5 1.4 mM Sodium pyruvate, 20 mM HEPES, 0.15% Sodium bicarbonate, 100 U/ml penicillin, 100 µg/ml streptomycin, 2 mM glutamine, non-essential amino acids and 2 mg/ml G418). Ca<sup>2+</sup> influx was examined in the capsaicin-stimulated clones. A high responder clone was selected and used for further 10 experiments in the project. The human VR1-CHO<sub>luc9aeq</sub> cells were maintained in the selection medium and passaged every 3-4 days at 1-2.5x10<sup>5</sup> cells/flask (75 mm<sup>2</sup>).

(2) Measurement of Ca<sup>2+</sup> influx using FDSS-3000

15 Human VR1-CHO<sub>luc9aeq</sub> cells were suspended in a culture medium which is the same as the selection medium except for G418 and seeded at a density of 1,000 cells per well into 384-well plates (black walled clear-base / Nalge Nunc International). Following the culture for 48 hrs the medium was changed to 2 µM Fluo-3 AM (Molecular Probes) and 0.02% Puronic F-127 in 20 assay buffer (Hank's balanced salt solution (HBSS), 17 mM HEPES (pH7.4), 1 mM Probenecid, 0.1% BSA) and the cells were incubated for 60 min at 25°C. After washing twice with assay buffer the cells were incubated with a test compound or vehicle for 20 min at 25°C. Mobilization of cytoplasmic 25 Ca<sup>2+</sup> was measured by FDSS-3000 ( $\lambda_{ex}$ =488nm,  $\lambda_{em}$ =540nm / Hamamatsu Photonics) for 60 sec after the stimulation with 10 nM capsaicin. Integral R was calculated and compared with controls.

[Measurement of the capsaicin-induced  $\text{Ca}^{2+}$  influx in primary cultured rat dorsal root ganglia neurons] (Assay 2)

(1) Preparation of rat dorsal root ganglia neurons

5

New born Wister rats (5-11 days) were sacrificed and dorsal root ganglia (DRG) was removed. DRG was incubated with 0.1% trypsin (Gibco BRL) in PBS(-) (Gibco BRL) for 30 min at 37°C, then a half volume of fetal calf serum (FCS) was added and the cells were spun down. The DRG neuron cells 10 were resuspended in Ham F12/5% FCS/5% horse serum (Gibco BRL) and dispersed by repeated pipetting and passing through 70  $\mu\text{m}$  mesh (Falcon). The culture plate was incubated for 3 hours at 37°C to remove contaminating Schwann cells. Non-adherent cells were recovered and further cultured in laminin-coated 384 well plates (Nunc) at  $1 \times 10^4$  cells/50  $\mu\text{l}/\text{well}$  for 2 days in 15 the presence of 50 ng/ml recombinant rat NGF (Sigma) and 50  $\mu\text{M}$  5-fluorodeoxyuridine (Sigma).

(2)  $\text{Ca}^{2+}$  mobilization assay

20

DRG neuron cells were washed twice with HBSS supplemented with 17 mM HEPES (pH 7.4) and 0.1% BSA. After incubating with 2  $\mu\text{M}$  fluo-3AM (Molecular Probe), 0.02% PF127 (Gibco BRL) and 1 mM probenecid (Sigma) for 40 min at 37°C, cells were washed 3 times. The cells were 25 incubated with VR1 antagonists or vehicle (dimethylsulphoxide) and then with 1  $\mu\text{M}$  capsaicin in FDSS-6000 ( $\lambda_{\text{ex}}=480\text{nm}$ ,  $\lambda_{\text{em}}=520\text{nm}$  / Hamamatsu Photonics). The fluorescence changes at 480nm were monitored for 2.5 min. Integral R was calculated and compared with controls.

## [Organ bath assay to measure the capsaicin-induced bladder contraction] (Assay 3)

Male Wistar rats (10 week old) were anesthetized with ether and sacrificed by dislocating the necks. The whole urinary bladder was excised and placed in 5 oxygenated Modified Krebs-Henseleit solution (pH 7.4) of the following composition (112 mM NaCl, 5.9 mM KCl, 1.2 mM MgCl<sub>2</sub>, 1.2 mM NaH<sub>2</sub>PO<sub>4</sub>, 2 mM CaCl<sub>2</sub>, 2.5 mM NaHCO<sub>3</sub>, 12 mM glucose). Contractile responses of the urinary bladder were studied as described previously [Maggi CA et al: Br.J.Pharmacol. 108: 801-805, 1993]. Isometric tension was recorded under a load of 1 g using 10 longitudinal strips of rat detrusor muscle. Bladder strips were equilibrated for 60 min before each stimulation. Contractile response to 80 mM KCl was determined at 15 min intervals until reproducible responses were obtained. The response to KCl was used as an internal standard to evaluate the maximal response to capsaicin. The effects of the compounds were investigated by incubating the strips with compounds 15 for 30 min prior to the stimulation with 1 µM capsaicin (vehicle: 80% saline, 10% EtOH, and 10% Tween 80). One of the preparations made from the same animal was served as a control while the others were used for evaluating compounds. Ratio of each capsaicin-induced contraction to the internal standard (i.e. KCl-induced contraction) was calculated and the effects of the test compounds on the capsaicin- 20 induced contraction were evaluated.

[Measurement of Ca<sup>2+</sup> influx in the human P2X1-transfected CHO cell line]

## (1) Preparation of the human P2X1-transfected CHOLuc9aeq cell line

25

Human P2X1-transfected CHOLuc9aeq cell line was established and maintained in Dulbecco's modified Eagle's medium (DMEM/F12) supplemented with 7.5% FCS, 20 mM HEPES-KOH (pH 7.4), 1.4 mM sodium pyruvate, 100 U/ml penicillin, 100 µg/ml streptomycin, 2 mM glutamine (Gibco BRL) and 0.5 Units/ml apyrase (grade I, Sigma). The suspended cells were seeded in each well of 384-well optical bottom black 30

plates (Nalge Nunc International) at  $3 \times 10^3$  / 50  $\mu$ l / well. The cells were cultured for following 48 hrs to adhere to the plates.

5 (2) Measurement of the intracellular  $\text{Ca}^{2+}$  levels

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P2X1 receptor agonist-mediated increases in cytosolic  $\text{Ca}^{2+}$  levels were measured using a fluorescent  $\text{Ca}^{2+}$  chelating dye, Fluo-3 AM (Molecular Probes). The plate-attached cells were washed twice with washing buffer (HBSS, 17 mM HEPES-KOH (pH 7.4), 0.1% BSA and 0.5 units/ml apyrase), and incubated in 40  $\mu$ l of loading buffer (1  $\mu$ M Fluo-3 AM, 1 mM probenecid, 1  $\mu$ M cyclosporin A, 0.01% pluronic (Molecular Probes) in washing buffer) for 1 hour in a dark place. The plates were washed twice with 40  $\mu$ l washing buffer and 35  $\mu$ l of washing buffer were added in each well with 5  $\mu$ l of test compounds or 2',3'-o-(2,4,6-trinitrophenyl) adenosine 5'-triphosphate (Molecular Probes) as a reference. After further incubation for 10 minutes in dark 200 nM  $\alpha$ ,  $\beta$ -methylene ATP agonist was added to initiate the  $\text{Ca}^{2+}$  mobilization. Fluorescence intensity was measured by FDSS-6000 ( $\lambda_{\text{ex}}=410\text{nm}$ ,  $\lambda_{\text{em}}=510\text{nm}$  / Hamamatsu Photonics) at 250 msec intervals. Integral ratios were calculated from the data and compared with that of a control.

[Measurement of capsaicin-induced bladder contraction in anesthetized rats]  
(Assay 4)

25 (1) Animals

Female Sprague-Dawley rats (200~250 g / Charles River Japan) were used.

## (2) Catheter implantation

Rats were anesthetized by intraperitoneal administration of urethane (Sigma) at 1.2 g/kg. The abdomen was opened through a midline incision, and a 5 polyethylene catheter (BECTON DICKINSON, PE50) was implanted into the bladder through the dome. In parallel, the inguinal region was incised, and a polyethylene catheter (Hibiki, size 5) filled with 2 IU / ml of heparin (Novo Heparin, Aventis Pharma) in saline (Otsuka) was inserted into a common iliac artery.

10

## (3) Cystometric investigation

The bladder catheter was connected via T-tube to a pressure transducer (Viggo-Spectramed Pte Ltd, DT-XXAD) and a microinjection pump (TERUMO). Saline was infused at room temperature into the bladder at a rate 15 of 2.4 ml/hr. Intravesical pressure was recorded continuously on a chart pen recorder (Yokogawa). At least three reproducible micturition cycles, corresponding to a 20-minute period, were recorded before a test compound administration and used as baseline values.

20

## (4) Administration of test compounds and stimulation of bladder with capsaicin

The saline infusion was stopped before administrating compounds. A testing compound dissolved in the mixture of ethanol, Tween 80 (ICN Biomedicals Inc.) and saline (1 : 1 : 8, v/v/v) was administered intraarterially at 25 10 mg/kg. 2min after the administration of the compound 10  $\mu$ g of capsaicin (Nacalai Tesque) dissolved in ethanol was administered intraarterially.

## (5) Analysis of cystometry parameters

Relative increases in the capsaicin-induced intravesical pressure were analyzed from the cystometry data. The capsaicin-induced bladder pressures were compared with the maximum bladder pressure during micturition without the capsaicin stimulation. The testing compounds-mediated inhibition of the increased bladder pressures was evaluated using Student's t-test. A probability level less than 5% was accepted as significant difference.

## 10 [Measurement of over active bladder in anesthetized cystitis rats] (Assay 5)

## (1) Animals

Female Sprague-Dawley rats (180~250 g / Charles River Japan) were used. Cyclophosphamide (CYP) dissolved in saline was administered intraperitoneally at 150 mg/kg 48 hours before experiment.

## (2) Catheter implantation

20 Rats were anesthetized by intraperitoneal administration of urethane (Sigma) at 1.25 g/kg. The abdomen was opened through a midline incision, and a polyethylene catheter (BECTON DICKINSON, PE50) was implanted into the bladder through the dome. In parallel, the inguinal region was incised, and a polyethylene catheter (BECTON DICKINSON, PE50) filled with saline (Otsuka) was inserted into a femoral vein. After the bladder was emptied, the rats were left for 1 hour for recovery from the operation.

## (3) Cystometric investigation

30 The bladder catheter was connected via T-tube to a pressure transducer (Viggo-Spectramed Pte Ltd, DT-XXAD) and a microinjection pump

(TERUMO). Saline was infused at room temperature into the bladder at a rate of 3.6 ml/hr for 20 min. Intravesical pressure was recorded continuously on a chart pen recorder (Yokogawa). At least three reproducible micturition cycles, corresponding to a 20-minute period, were recorded before a test compound 5 administration.

10 (4) Administration of test compounds

A testing compound dissolved in the mixture of ethanol, Tween 80 (ICN Biomedicals Inc.) and saline (1 : 1 : 8, v/v/v) was administered intravenously 10 at 0.05 mg/kg, 0.5 mg/kg or 5 mg/kg. 3min after the administration of the compound, saline (Nacalai Tesque) was infused at room temperature into the bladder at a rate of 3.6 ml/hr.

15 (5) Analysis of cystometry parameters

The cystometry parameters were analyzed as described previously [ Lecci A et al: Eur. J. Pharmacol. 259: 129-135, 1994]. The micturition frequency calculated from micturition interval and the bladder capacity calculated from 20 a volume of infused saline until the first micturition were analyzed from the cystometry data. The testing compounds-mediated inhibition of the frequency and the testing compounds-mediated increase of bladder capacity were evaluated using unpaired Student's t-test. A probability levels less than 5% 25 was accepted as significant difference. Data were analyzed as the mean  $\pm$  SEM from 4 – 7 rats.

[Measurement of Acute Pain]

30 Acute pain is measured on a hot plate mainly in rats. Two variants of hot plate testing are used: In the classical variant animals are put on a hot surface (52 to 56°C) and the latency time is measured until the animals show nociceptive

5 behavior, such as stepping or foot licking. The other variant is an increasing temperature hot plate where the experimental animals are put on a surface of neutral temperature. Subsequently this surface is slowly but constantly heated until the animals begin to lick a hind paw. The temperature which is reached when hind paw licking begins is a measure for pain threshold.

10 Compounds are tested against a vehicle treated control group. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to pain testing.

[Measurement of Persistent Pain]

15 Persistent pain is measured with the formalin or capsaicin test, mainly in rats. A solution of 1 to 5% formalin or 10 to 100 µg capsaicin is injected into one hind paw of the experimental animal. After formalin or capsaicin application the animals show nociceptive reactions like flinching, licking and biting of the affected paw. The number of nociceptive reactions within a time frame of up to 90 minutes is a measure for intensity of pain.

20 Compounds are tested against a vehicle treated control group. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to formalin or capsaicin administration.

25 [Measurement of Neuropathic Pain]

30 Neuropathic pain is induced by different variants of unilateral sciatic nerve injury mainly in rats. The operation is performed under anesthesia. The first variant of sciatic nerve injury is produced by placing loosely constrictive ligatures around the common sciatic nerve (Bennett and Xie, Pain 33 (1988):

87-107). The second variant is the tight ligation of about the half of the diameter of the common sciatic nerve (Seltzer et al., Pain 43 (1990): 205-218). In the next variant, a group of models is used in which tight ligations or transections are made of either the L5 and L6 spinal nerves, or the L5 spinal nerve only (KIM SH; CHUNG JM, AN EXPERIMENTAL-MODEL FOR PERIPHERAL NEUROPATHY PRODUCED BY SEGMENTAL SPINAL NERVE LIGATION IN THE RA, PAIN 50 (3) (1992): 355-363). The fourth variant involves an axotomy of two of the three terminal branches of the sciatic nerve (tibial and common peroneal nerves) leaving the remaining sural nerve intact whereas the last variant comprises the axotomy of only the tibial branch leaving the sural and common nerves uninjured. Control animals are treated with a sham operation.

Postoperatively, the nerve injured animals develop a chronic mechanical allodynia, cold allodynica, as well as a thermal hyperalgesia. Mechanical allodynia is measured by means of a pressure transducer (electronic von Frey Anesthesiometer, IITC Inc.-Life Science Instruments, Woodland Hills, SA, USA; Electronic von Frey System, Somedic Sales AB, Hörby, Sweden). Thermal hyperalgesia is measured by means of a radiant heat source (Plantar Test, Ugo Basile, Comerio, Italy), or by means of a cold plate of 5 to 10 °C where the nocifensive reactions of the affected hind paw are counted as a measure of pain intensity. A further test for cold induced pain is the counting of nocifensive reactions, or duration of nocifensive responses after plantar administration of acetone to the affected hind limb. Chronic pain in general is assessed by registering the circadian rhythms in activity (Surjo and Arndt, Universität zu Köln, Cologne, Germany), and by scoring differences in gait (foot print patterns; FOOTPRINTS program, Klapdor et al., 1997. A low cost method to analyse footprint patterns. J. Neurosci. Methods 75, 49-54).

Compounds are tested against sham operated and vehicle treated control groups. Substance application is performed at different time points via

different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to pain testing.

5 [Measurement of Inflammatory Pain]

Inflammatory pain is induced mainly in rats by injection of 0.75 mg carrageenan or complete Freund's adjuvant into one hind paw. The animals 10 develop an edema with mechanical allodynia as well as thermal hyperalgesia. Mechanical allodynia is measured by means of a pressure transducer (electronic von Frey Anesthesiometer, IITC Inc.-Life Science Instruments, Woodland Hills, CA, USA). Thermal hyperalgesia is measured by means of a radiant heat source (Plantar Test, Ugo Basile, Comerio, Italy, Paw thermal 15 stimulator, G. Ozaki, University of California, USA). For edema measurement two methods are being used. In the first method, the animals are sacrificed and the affected hindpaws sectioned and weighed. The second method comprises differences in paw volume by measuring water displacement in a plethysmometer (Ugo Basile, Comerio, Italy).

20 Compounds are tested against uninflamed as well as vehicle treated control groups. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to pain testing.

25 [Measurement of Diabetic Neuropathic Pain]

Rats treated with a single intraperitoneal injection of 50 to 80 mg/kg streptozotocin develop a profound hyperglycemia and mechanical allodynia 30 within 1 to 3 weeks. Mechanical allodynia is measured by means of a pressure transducer (electronic von Frey Anesthesiometer, IITC Inc.-Life Science Instruments, Woodland Hills, CA, USA).

Compounds are tested against diabetic and non-diabetic vehicle treated control groups. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to pain testing.

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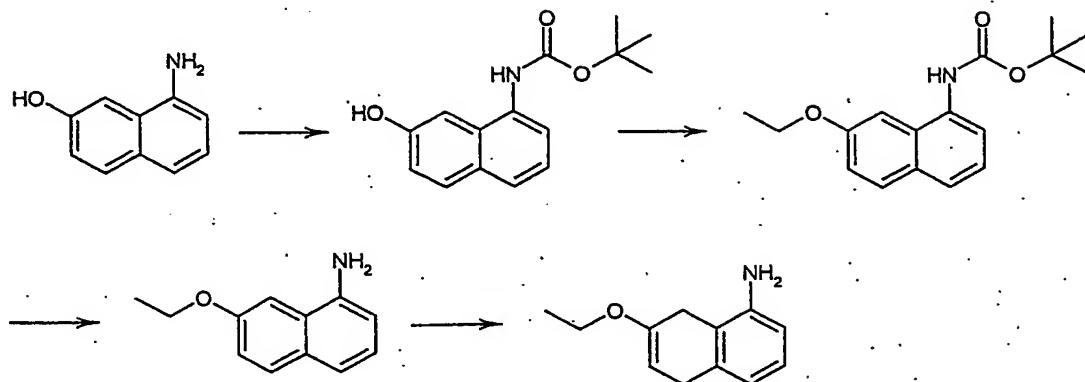
Results of  $IC_{50}$  of capsaicin-induced  $Ca^{2+}$  influx in the human VR1-transfected CHO cell line are shown in Examples and tables of the Examples below. The data corresponds to the compounds as yielded by solid phase synthesis and thus to levels of purity of about 40 to 90%. For practical reasons, the compounds are grouped in 10 four classes of activity as follows:

$$IC_{50} = A (< \text{or } =) 0.1 \mu M < B (< \text{or } =) 0.5 \mu M < C (< \text{or } =) 1 \mu M < D$$

15 The compounds of the present invention also show excellent selectivity, and strong activity in other assays (2)-(5) described above.

### Preparing method of starting compounds

#### [Starting compound A]



To a stirred solution of 8-amino-2-naphthol (50.0 g, 314 mmol) in tetrahydrofuran (1000 mL) was added di-t-butyl dicarbonate (68.6 g, 314 mmol). The mixture was stirred at 70°C for 18 hours. After the mixture was cooled to room temperature, solvent was removed under reduced pressure. To the residue was added ethylacetate, and washed with saturated aqueous solution of sodium carbonate and then with water. The extracted organic layer was dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated under reduced pressure. To the obtained residue was added diisopropyl ether, and the precipitate was filtered and dried to afford N-t-butoxycarbonyl-8-amino-2-naphthol (64.2 g, 79 % yield).

15 MS (ESI) m/z 259 [M]<sup>+</sup>

<sup>1</sup>H NMR (DMSO-*d*6)  $\delta$  1.48 (s, 9H), 7.07 (dd, *J* = 2.2 Hz and 8.85 Hz, 1H), 7.20 (t, *J* = 7.9 Hz, 1H), 7.24 (d, *J* = 2.2 Hz, 1H), 7.36 (d, *J* = 7.25 Hz, 1H), 7.60 (d, *J* = 8.2 Hz, 1H), 7.75 (d, *J* = 8.8 Hz, 1H), 8.92 (s, 1H).

20

Next, to a mixture of N-t-butoxycarbonyl-8-amino-2-naphthol (64.0 g, 247 mmol) and Cesium carbonate (161 g, 493 mmol) in 300 mL anhydrous DMF was added iodoethane (42.3 g, 272 mmol) at room temperature. The mixture was stirred at 60°C for 2 hours. Water was added to the mixture, and the product was extracted with

ethylacetate. The organic layer was washed with water and brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated under reduced pressure. To the obtained residue was added diisopropyl ether and the precipitate was collected and dried to afford (7-ethoxy-naphthalen-1-yl)-carbamic acid t-butyl ester (47.9 g, 67.5 % yield).

5 MS (ESI) m/z 287[M]<sup>+</sup>

<sup>1</sup>H NMR (DMSO-*d*6)  $\delta$  1.41 (t, *J* = 6.95 Hz, 3H), 1.50 (s, 9H), 4.16 (q, *J* = 6.95 Hz, 2H), 7.15 (dd, *J* = 2.55 and 8.8 Hz, 1H), 7.28 (t, *J* = 8.8 Hz, 1H), 7.36 (d, *J* = 2.2 Hz, 1H), 7.54 (d, *J* = 7.25 Hz, 1H), 7.61 (d, *J* = 8.2 Hz, 1H), 7.80 (d, *J* = 8.85 Hz, 1H), 9.12(s, 1H).

10

Next, to a (7-ethoxy-naphthalen-1-yl)-carbamic acid t-butyl ester (47.9 g, 167 mmol) in 100 mL anhydrous 1,4-dioxane was added 4N HCl in 1,4-dioxane (100 mL) at 0°C. The mixture was stirred at room temperature for 2 hours. Diisopropyl ether was added to the reaction mixture and the precipitate was filtered. To the obtained 15 solid was added saturated sodium bicarbonate and the product was extracted with ethylacetate. The organic layer was dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated under reduced pressure to afford 7-ethoxy-naphthalen-1-ylamine (27.0 g, 86.3 % yield).

MS (ESI) m/z 187 [M]<sup>+</sup>

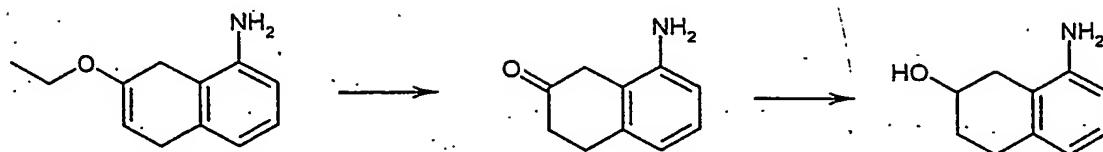
20 <sup>1</sup>H NMR (DMSO-*d*6)  $\delta$  1.39 (t, *J* = 11.3 Hz, 3H), 4.15 (q, *J* = 11.3 Hz, 2H), 5.52(s(br), 2H), 6.64 (dd, *J* = 3.75 and 10.05 Hz, 1H), 7.01-7.07 (m, 3H), 7.39 (d, *J* = 3.8 Hz, 1H), 7.63 (d, *J* = 14.45 Hz, 1H).

25 Next, to a flask containing a mixture of 7-ethoxy-naphthalen-1-ylamine (1.80 g, 9.61 mmol) and t-buthanol (2.13 g, 28.8 mmol) in tetrahydrofuran (20 mL) was collected liquid ammonia (300 mL) at -78°C. To the mixture was added lithium (0.200 g, 28.8 mmol) over 30 minutes and stirred at -78°C for 1 hour. Methanol and water was added, and the mixture was stirred at room temperature for 16 hours to allow ammonia to evaporate. To the obtained residue was added ethylacetate. The 30 organic layer was washed with water, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated

under reduced pressure to afford 7-ethoxy-5,8-dihydronaphthalen-1-ylamine (1.37 g, 76% yield).

**[Starting compound B]**

5



To a stirred solution of 7-ethoxy-5,8-dihydronaphthalen-1-ylamine (1.07 g, 5.65 mmol) in tetrahydrofuran (30 mL) was added solution of aqueous 2N HCl (10 mL), and stirred at 40°C for 1 hour. The mixture was neutralized with addition of sodium bicarbonate, and the product was extracted with ethylacetate. The organic layer was washed with water, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated under reduced pressure to afford 8-amino-3,4-dihydro-1H-naphthalen-2-one (0.71 g, 78% yield).

15 MS (ESI) m/z 162 [M+H]<sup>+</sup>

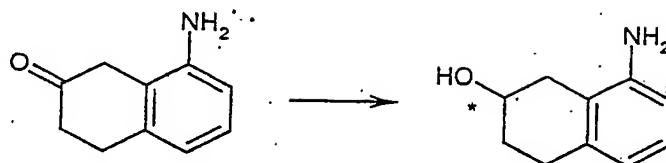
<sup>1</sup>H NMR (CDCl<sub>3</sub>)  $\delta$  2.62-2.65 (m, 2H), 3.07 (t,  $J$  = 7.25 Hz, 2H), 3.34(s, 2H), 6.65 (d,  $J$  = 7.85, 1H), 6.70 (d,  $J$  = 7.25 Hz, 1H), 7.07 (t,  $J$  = 7.55 Hz, 1H).

Next, to 8-amino-3,4-dihydro-1H-naphthalen-2-one (0.050 g, 0.318 mmol) in methanol (10 mL) was added sodium borohydride (0.030 g, 0.175 mmol) at 0°C, and the mixture was stirred for 1 hour. The mixture was poured into water, and the product was extracted with ethylacetate. The organic layer was dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated under reduced pressure to afford 8-amino-1,2,3,4-tetrahydro-naphthalen-2-ol (0.037 g, 71 % yield).

25 MS (ESI) m/z 163 [M]<sup>+</sup>

<sup>1</sup>H NMR (DMSO-*d*6)  $\delta$  1.53-1.57 (m, 1H), 1.81-1.85 (m, 1H), 2.16 (dd,  $J$  = 7.7 and 16.4 Hz, 1H), 2.61-2.74 (m, 3H), 3.89-3.90 (m, 1H), 4.65 (s, 2H), 4.72 (d,  $J$  = 4.1 Hz, 1H), 6.28 (d,  $J$  = 7.45 Hz, 1H), 6.28 (d,  $J$  = 7.45 Hz, 1H), 6.41 (d,  $J$  = 7.7 Hz, 1H), 6.76(t,  $J$  = 7.55 Hz, 1H).

## [Starting compound C]



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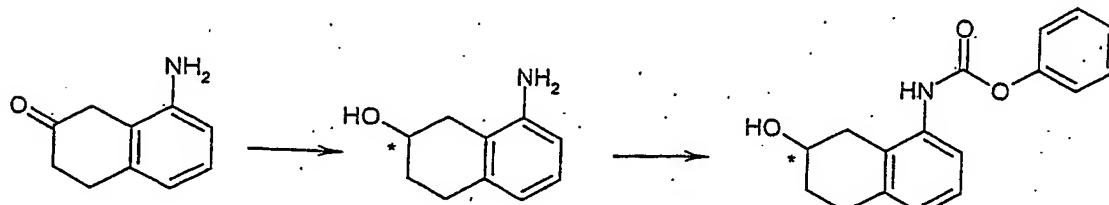
To a stirred solution benzene ruthenium(II) chloride dimer (3.10 mg, 0.006 mmol) and (1S, 2R)-(-)-cis-1-amino-2-indanol (3.7 mg, 0.025 mmol) in degassed isopropanol was heated at 80°C for 20 minutes under argon. The mixture was added to the solution of 8-amino-3,4-dihydro-1H-naphthalen-2-one (50 mg, 0.310 mmol) in isopropanol (3 mL) at room temperature. A solution of potassium hydroxide (3.48 mg, 0.062 mmol) in isopropanol (1 mL) was added, and the mixture was stirred at 45°C for 1 hour. The mixture was passed through silica gel and washed with ethylacetate. The filtrate was concentrated under reduced pressure to afford the chiral 8-amino-1,2,3,4-tetrahydro-naphthalen-2-ol enantiomer (33.0 mg, 65 % yield).

15 MS (ESI) m/z 163 [M]<sup>+</sup>

<sup>1</sup>H NMR (DMSO-*d*6) δ 1.53-1.57 (m, 1H), 1.81-1.85 (m, 1H), 2.16 (dd, *J* = 7.7 and 16.4 Hz, 1H), 2.61-2.74 (m, 3H), 3.89-3.90 (m, 1H), 4.65 (s, 2H), 4.72 (d, *J* = 4.1 Hz, 1H), 6.28 (d, *J* = 7.45 Hz, 1H), 6.28 (d, *J* = 7.45 Hz, 1H), 6.41 (d, *J* = 7.7 Hz, 1H), 6.76 (t, *J* = 7.55 Hz, 1H).

20

## [Starting compound D]



A stirred solution benzene ruthenium(II) chloride dimer (1.55 g) and (1S, 2R)-(-)-*cis*-1-amino-2-indanol (1.85 g) in degassed isopropanol (500 ml) was heated at 80°C for 20 minutes under argon, and then cooled to room temperature. The mixture was added to the solution of 8-amino-3,4-dihydro-1H-naphthalen-2-one (25.0 g) in isopropanol (700 ml) at room temperature followed by the prepared solution of potassium hydroxide (1.74 g) in 300 ml of isopropanol (pre-prepared at 45°C to dissolve and then cooled to room temperature). After stirred at 45°C for 30 minutes, the mixture was cooled to room temperature and was passed through silica gel pad and washed with ethylacetate. The filtrate was concentrated under reduced pressure, and the obtained solid was dissolved in dichloromethane and treated with activated charcoal for 10 minutes. After filtered through a silica gel pad, the mixture was concentrated under reduced pressure. The obtained product was recrystallized from dichloromethane to afford red crystal of (R)-8-amino-1,2,3,4-tetrahydro-naphthalen-2-ol (14g, 56 % yield).

15 MS (ESI) m/z 163 [M]<sup>+</sup>

<sup>1</sup>H NMR (DMSO-*d*6) δ 1.53-1.57 (m, 1H), 1.81-1.85 (m, 1H), 2.16 (dd, *J* = 7.7 and 16.4 Hz, 1H), 2.61-2.74 (m, 3H), 3.89-3.90 (m, 1H), 4.65 (s, 2H), 4.72 (d, *J* = 4.1 Hz, 1H), 6.28 (d, *J* = 7.45 Hz, 1H), 6.28 (d, *J* = 7.45 Hz, 1H), 6.41 (d, *J* = 7.7 Hz, 1H), 6.76(t, *J* = 7.55 Hz, 1H).

20

Use of (1R, 2S)-(+)-*cis*-1-amino-2-indanol resulted in of (S)-8-amino-1,2,3,4-tetrahydro-naphthalen-2-ol.

Next, a solution of (R)-8-amino-1,2,3,4-tetrahydro-naphthalen-2-ol (36.2 g) and 25 pyridine (18.8 ml) in THF (850 ml) cooled at 0 °C was added phenyl chloroformate (28.8 ml). The mixture was stirred for 3 hours at room temperature, and then poured into ethylacetate. The mixture was washed with aqueous NH<sub>4</sub>Cl then with water, and the organic layer was dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated under reduced pressure. To the obtained residue was added acetonitrile, and the precipitates were 30 collected and washed with a mixture of acetonitrile and diisopropyl ether (2:3) to

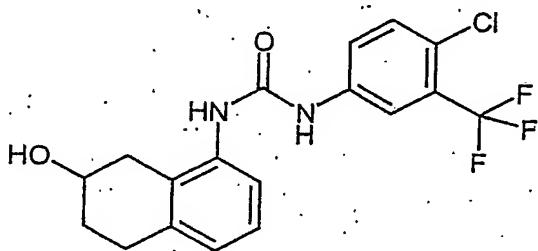
obtain {*(R*)-7-Hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-carbamic acid phenyl ester (33.0 g).

MS (ESI) m/z 284 [M+H]<sup>+</sup>

<sup>1</sup>H NMR (DMSO-*d*6) δ 1.59-1.64 (m, 1H), 1.83-1.89 (m, 1H), 2.68-2.99 (m, 4H), 3.90-3.92 (m, 1H), 4.84 (dd, *J* = 3.8 Hz and 29.9 Hz, 1H), 6.75 (d, *J* = 7.9 Hz, 1H), 7.07-7.25 (m, 6H), 7.42 (t, *J* = 7.85 Hz, 1H), 9.29 (s, 1H).

Example 1-1

10 N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea



15 This example was performed according to the general method F:

To a stirred solution of 7-ethoxy-5,8-dihydronaphthalen-1-ylamine (0.16 g, 0.84 mmol) in tetrahydrofuran (15 mL) was added 4-chloro-3-trifluoromethyl-phenylisocyanate (0.22 g, 1.0 mmol). The mixture was stirred at room temperature for 1.5 hours and was poured into water. The product was extracted with ethyl-acetate, and the organic layer was dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated under reduced pressure to afford N-(4-chloro-3-trifluoromethyl-phenyl)-N'-(7-ethoxy-5,8-dihydro-naphthalen-1-yl)urea (0.31 g, 89 % yield). Next, to a solution of N-(4-chloro-3-trifluoromethyl-phenyl)-N'-(7-ethoxy-5,8-dihydro-naphthalen-1-yl)-urea (0.21 g, 0.51 mmol) in tetrahydrofuran (20 mL) was added a solution of aqueous 1N hydrochloric acid (5 mL), and the mixture was stirred at 40°C for 45 minutes. The mixture was neutralized with addition of 10 % aqueous sodium bicarbonate

- 50 -

solution, and extracted with ethylacetate. The organic layer was dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated under reduced pressure to afford N-(4-chloro-3-trifluoromethyl-phenyl)-N'-(7-oxo-5,6,7,8-tetrahydro-naphthalen-1-yl)urea (0.16 g, 85 % yield). Next, to N-(4-chloro-3-trifluoromethyl-phenyl)-N'-(7-oxo-5,6,7,8-tetrahydro-naphthalen-1-yl)urea (0.07 g, 0.18 mmol) in methanol (10 mL) was added sodium borohydride (0.04 g, 0.09 mmol) at 0°C, and the mixture was stirred for 30 minutes. The mixture was poured into water, and the product was extracted with ethylacetate. The organic layer was dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated under reduced pressure, and the obtained product was recrystallized from a mixture of ethylacetate / hexane (1 / 2) solution to give N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea (41 mg, 59 % yield)

<sup>1</sup>H NMR (DMSO-*d*6)  $\delta$  1.57-1.58 (m, 1H), 1.87-1.90 (m, 1H), 2.36-2.42 (m, 1H), 2.63-2.76 (m, 1H), 2.83-2.87 (m, 2H), 3.91-3.96 (m, 1H), 4.87 (d, *J* = 4.1 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 7.06 (t, *J* = 7.6 Hz, 1H), 7.58 (d, *J* = 7.6 Hz, 1H), 7.61-7.62 (m, 2H), 7.93 (s, 1H), 8.09 (s, 1H), 9.47 (s, 1H).

Molecular weight: 384.8

MS (M+H): 384

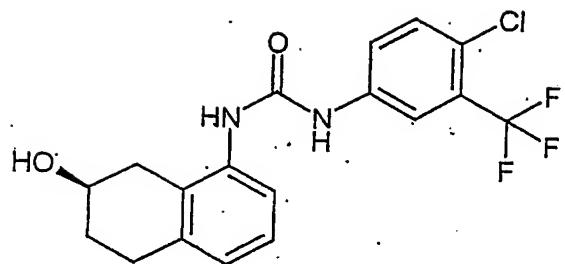
mp: 227-228°C

20 In-vitro activity class: A

Example 1-2

25 N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(*(R)*-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl}urea

- 51 -



5 A racemic mixture of N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea (30.0 mg) was separated by chiral HPLC (Daicel OD column, n-hexane : 2-propanol = 98 : 2) to the corresponding R-isomer (8.3 mg). Chiral HPLC (ChiralCel OD 0.49 cm x 25 cm column, n-hexane / ethanol = 97 / 3, flow rate 1.5 mL/min) R-isomer was detected at 20.1 minutes.

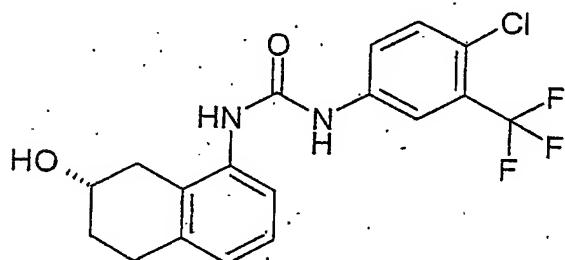
10 Molecular weight: 384.8

MS (M+H): 384

10

**Example 1-3**

N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(*(S)*-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea



15

15 A racemic mixture of N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea (30.0 mg) was separated by chiral HPLC (Daicel OD column, n-hexane : 2-propanol = 98 : 2) to the corresponding S-isomer (2.2 mg). Chiral HPLC (ChiralCel OD 0.49 cm x 25 cm column, n-hexane / ethanol = 97 / 3, flow rate 1.5 mL/min) S-isomer was detected at 17.6 minutes.

- 52 -

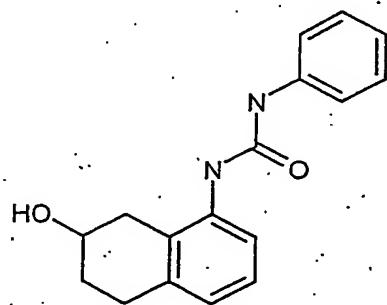
Molecular weight: 384.8

MS (M+H): 384

Example 2-1

5

**N-phenyl-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea**



10 This example was performed according to the general method A.

To a solution of 8-amino-1,2,3,4-tetrahydro-naphthalen-2-ol (20.0 mg, 0.123 mmol) in 1,4-dioxane (1.0 mL) was added phenyl isocyanate (14.6 mg, 0.123 mmol) at room temperature. The mixture was stirred for 16 hours, and then added diisopropyl ether and hexane. The precipitate was filtered and dried to give N-phenyl-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea (17.8 mg, 51 % yield).

15 Molecular weight: 282.3

MS (M+H): 283

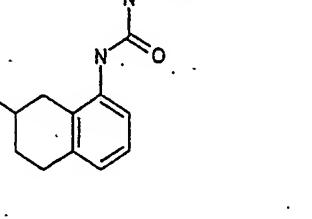
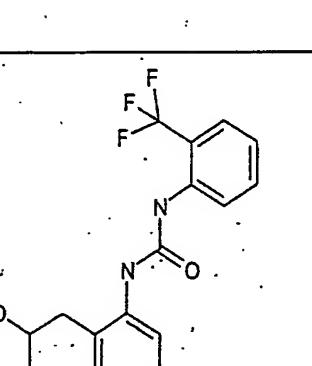
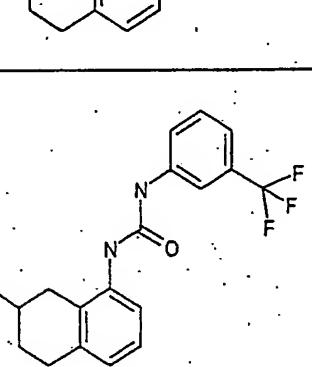
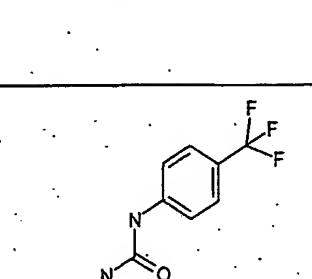
mp: 198-199 °C

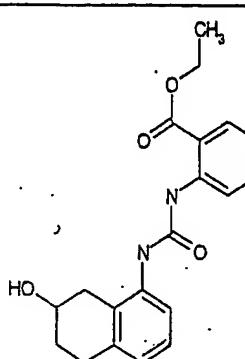
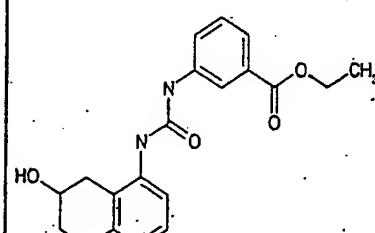
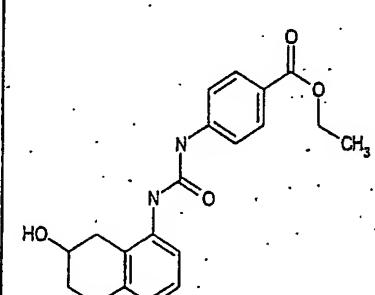
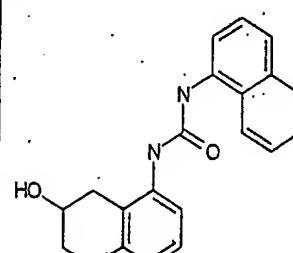
20 Activity class: C

With the use of the starting material B and according to procedures similar to the examples 2-1 above, the compounds in Example 2-2 to 2-41 were synthesized and tested.

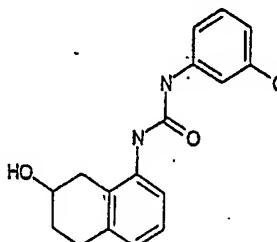
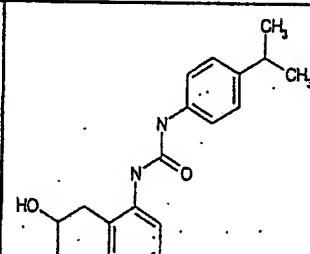
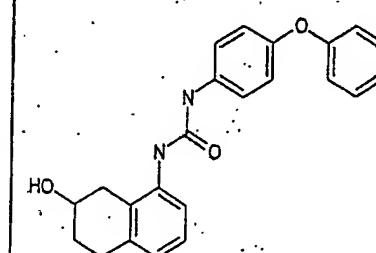
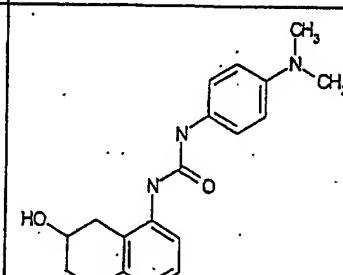
**Table 1**

Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-2		316,79024	317	197-199	B
2-3		316,79024	317	216-218	A
2-4		316,79024	317	229-231	A
2-5		312,3717	313	187-189	B

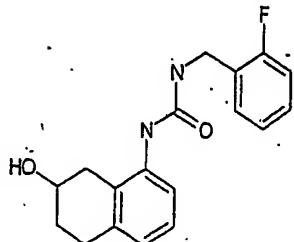
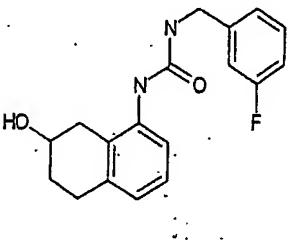
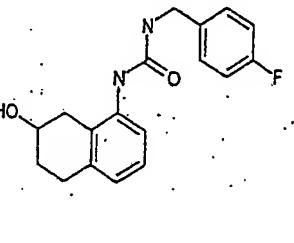
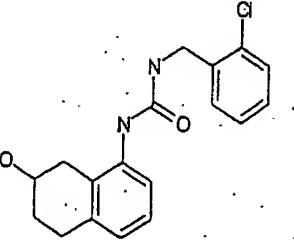
Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-6		312,3717	313	213-215	D
2-7		350,34359	351	217-219	C
2-8		350,34359	351	227-228	A
2-9		350,34359	351	222-224	A

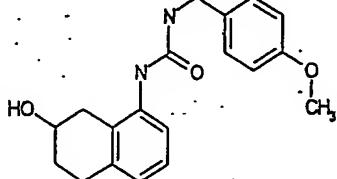
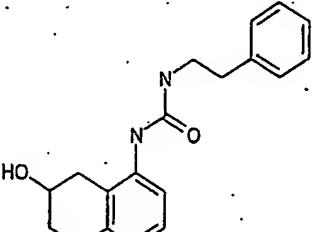
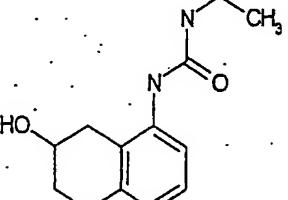
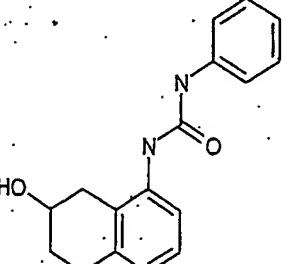
Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-10		354,40934	355	178-180	D
2-11		354,40934	355	176-178	A
2-12		354,40934	355	204-206	A
2-13		332,40575	333	250-252	A

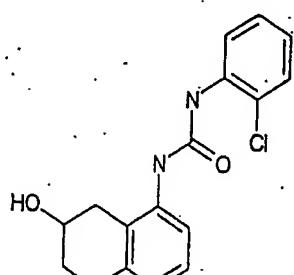
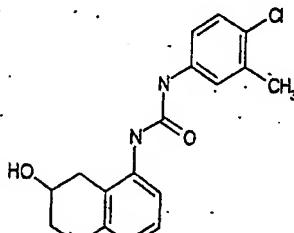
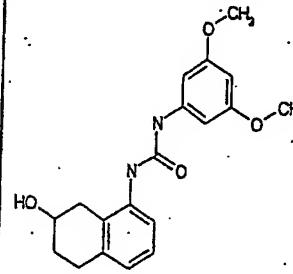
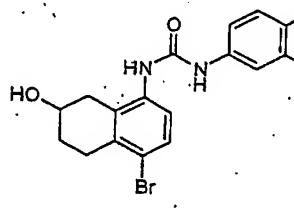
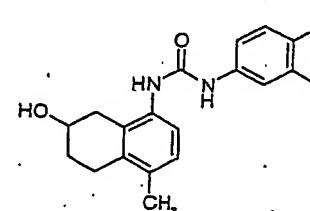
Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-14		332,40575	333	212-214	A
2-15		300,33564	301	214-216	B
2-16		361,24124	362	237-239	A
2-17		351,23527	352	234-235	A

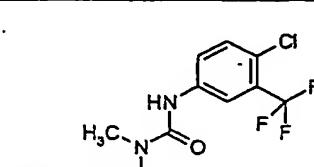
Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-18		296,3723	297	198-200	B
2-19		324,42648	325	186-188	A
2-20		374,44339	375	188-190	A
2-21		325,41406	326	206-207	D

Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-22		296,3723	297	198-200	B
2-23		310,39939	311	224-226	B
2-24		310,39939	311	194-196	B
2-26		310,39939	311	230-232	A

Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-27		314,36273	315	184-187	B
2-28		314,36273	315	193-194	B
2-29		314,36273	315	218-221	A
2-30		330,81733	331	213-215	B

Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-31		326,39879	327	209-211	B
2-32		310,39939	311	161-163	C
2-33		234,30061	235	216-217	D
2-34		282,34521	283	198-199	C

Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-35		316,79024	317	197-199	B
2-36		330,81733	331	>180Z	A
2-37		342,39819	343	>150Z	A
2-38		463,68465	464	234-235	A
2-39		398,81	399	219-220	A

Ex no	MOLSTRUCTURE	MW	MS	MP	activity class
2-40		398,81571	399	136-137	B
2-41		398,81571	399	213	B

Example 3-1

N-(4-chloro-3-(trifluoromethyl)phenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea chiral enantiomer

5

This example was performed according to the general method G.

To a solution of chiral 8-amino-1,2,3,4-tetrahydro-naphthalen-2-ol enantiomer (33.0 mg, 0.202 mmol) in 1,4-dioxane (3.0 mL) was added 4-chloro-3-trifluoromethyl-phenylisocyanate (44.8 mg, 0.202 mmol) at room temperature. The mixture was stirred for 16 hours, and then added diisopropyl ether and hexane. The precipitate was filtered and dried to give chiral N-(4-chloro-3-(trifluoromethyl)phenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea (54.0 mg, 69 % yield). Enantiomeric excess (% ee) was measured by using Chiral Cel OD column (15 % isopropanol in hexane as eluent with 1 mL per minutes).

Molecular weight: 384.8

MS (M+H): 384

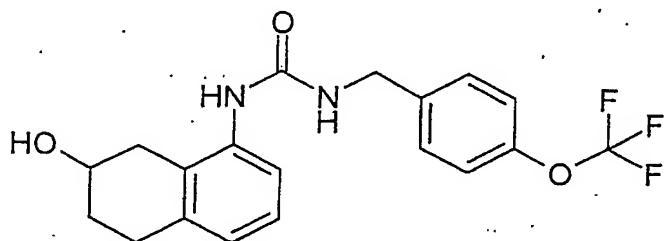
mp: 227-228°C

In vitro activity class: A

20

Example 4-1

N-(7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-N'-(4-trifluoromethoxybenzyl)-urea



25

This example was performed according to the general method C.

A mixture of 7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-carbamic acid phenyl ester (30.0 mg, 0.11 mmol) and 4-trifluoromethoxy-benzylamine (21.3 mg, 0.11 mmol) in DMSO (1.0 ml) was stirred at 100°C for 17 hours. The reaction mixture was cooled to room temperature, and water was added. Precipitates were filtered and washed with water then with acetonitrile to obtain N-(7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-N'-(4-trifluoromethoxy-benzyl)-urea (6.70 mg, 17% yield).

10  $^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  1.54-1.65 (m, 1H), 1.81-1.92 (m, 1H), 2.25-2.38 (m, 1H), 2.68-2.88 (m, 3H), 3.86-3.98 (m, 1H), 4.32 (d,  $J$  = 6.0 Hz, 2H), 4.85 (d,  $J$  = 4.1 Hz, 1H), 6.72 (d,  $J$  = 7.5 Hz, 1H), 6.98 (t,  $J$  = 7.5 Hz, 1H), 7.06 (t,  $J$  = 6.0 Hz, 1H), 7.34 (d,  $J$  = 8.3 Hz, 2H), 7.43 (d,  $J$  = 8.3 Hz, 2H), 7.63 (d,  $J$  = 7.5 Hz, 1H), 7.5 (s, 1H).

Molecular weight: 380.36

15 MS (M+H): 381

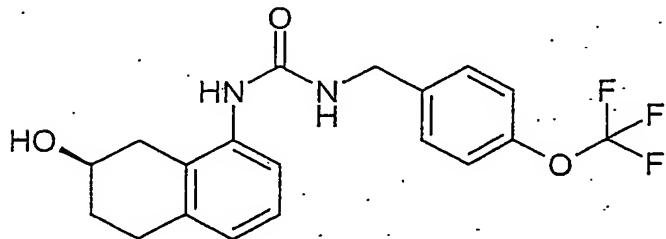
mp: 213 °C

In vitro activity class: A

#### Example 4-2

20

N-{(R)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-N'-(4-trifluoromethoxy-benzyl)-urea



This example was performed according to the general method C.

25

A mixture of (R)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-carbamic acid phenyl ester (147.3 mg, 0.52 mmol) and 4-trifluoromethoxy-benzylamine (99.4 mg, 0.52 mmol) in DMSO (1.5 ml) was stirred at 150°C for 1.5 hours. The reaction mixture was cooled to room temperature, and ethylacetate and water were added.

5 The extracted organic layer was washed with water then brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered and concentrated under reduced pressure. The obtained residue was triturated with dichloromethane and hexane to obtain N-{(R)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-N'-(4-trifluoromethoxy-benzyl)-urea (168.0 mg, 85 % yield).

10  $^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  1.54-1.65 (m, 1H), 1.81-1.92 (m, 1H), 2.25-2.38 (m, 1H), 2.68-2.88 (m, 3H), 3.86-3.98 (m, 1H), 4.32 (d,  $J$  = 6.0 Hz, 2H), 4.85 (d,  $J$  = 4.1 Hz, 1H), 6.72 (d,  $J$  = 7.5 Hz, 1H), 6.98 (t,  $J$  = 7.5 Hz, 1H), 7.06 (t,  $J$  = 6.0 Hz, 1H), 7.34 (d,  $J$  = 8.3 Hz, 2H), 7.43 (d,  $J$  = 8.3 Hz, 2H), 7.63 (d,  $J$  = 7.5 Hz, 1H), 7.5 (s, 1H).

Molecular weight: 380.36

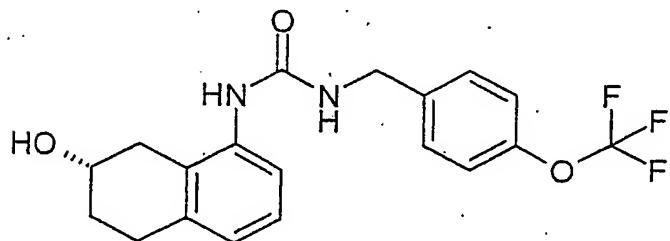
15 MS (M+H): 381

In vitro activity class: A

Chiral HPLC (ChiralCel AD 0.49 cm x 25 cm column, n-hexane / ethanol = 90 / 10, flow rate 1.5 mL/min) R-isomer was detected at 17.7 minutes.

20 Example 4-3

N-{(S)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-N'-(4-trifluoromethoxy-benzyl)-urea



25 This example was performed according to the general method C.

A mixture of (S)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-carbamic acid phenyl ester (85.0 mg, 0.30 mmol) and 4-trifluoromethoxy-benzylamine (57.4 mg, 0.30 mmol) in DMSO (1.0 ml) was stirred at 150°C for 1.5 hours. The reaction mixture was cooled to room temperature, and ethylacetate and water were added.

5 The extracted organic layer was washed with water then brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered and concentrated under reduced pressure. The obtained residue was triturated with dichloromethane and hexane to obtain N-{(S)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-N'-(4-trifluoromethoxy-benzyl)-urea (95.0 mg, 83 % yield).

10  $^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  1.54-1.65 (m, 1H), 1.81-1.92 (m, 1H), 2.25-2.38 (m, 1H), 2.68-2.88 (m, 3H), 3.86-3.98 (m, 1H), 4.32 (d,  $J$  = 6.0 Hz, 2H), 4.85 (d,  $J$  = 4.1 Hz, 1H), 6.72 (d,  $J$  = 7.5 Hz, 1H), 6.98 (t,  $J$  = 7.5 Hz, 1H), 7.06 (t,  $J$  = 6.0 Hz, 1H), 7.34 (d,  $J$  = 8.3 Hz, 2H), 7.43 (d,  $J$  = 8.3 Hz, 2H), 7.63 (d,  $J$  = 7.5 Hz, 1H), 7.5 (s, 1H).

Molecular weight: 380.36

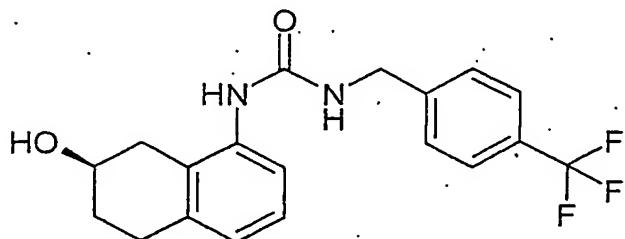
15 MS (M+H): 381

In vitro activity class: A

Chiral HPLC (ChiralCel AD 0.49 cm x 25 cm column, n-hexane / ethanol = 90 / 10, flow rate 1.5 mL/min) S-isomer was detected at 13.2 minutes.

20 Example 4-4

N-{(R)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-N'-(4-trifluoromethyl-benzyl)-urea



25 This example was performed according to the general method C.

A mixture of (R)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-carbamic acid phenyl ester (150.0 mg, 0.53 mmol) and 4-trifluoromethyl-benzylamine (92.7 mg, 0.53 mmol) in DMSO (2.0 ml) was stirred at 100°C for 1.5 hours. The reaction mixture was cooled to room temperature, and ethylacetate and water were added.

5 The extracted organic layer was washed with water then brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered and concentrated under reduced pressure. The obtained residue was triturated with dichloromethane and hexane to obtain N-{(R)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-N'-(4-trifluoromethyl-benzyl)-urea (156 mg, 81 % yield).

10  $^1\text{H}$  NMR (DMSO-*d*6)  $\delta$  1.58-1.59 (m, 1H), 1.85-1.86 (m, 1H), 2.33-2.85 (m, 4H), 3.91-3.92 (m, 1H), 4.39 (d, *J* = 5.7 Hz, 2H), 4.84 (d, *J* = 4.1 Hz, 1H), 6.72 (d, *J* = 7.25 Hz, 1H), 6.98 (t, *J* = 7.9 Hz, 1H), 7.12 (t, *J* = 6.0 Hz, 1H), 7.51-7.71 (m, 6H).

Molecular weight: 364.37

MS (M+H): 366

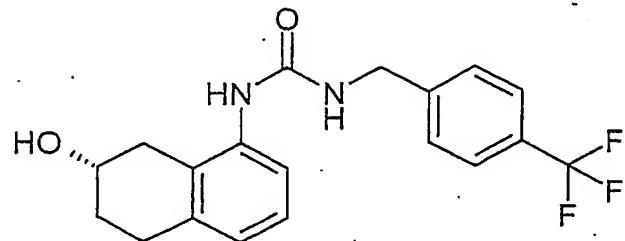
15 mp: 204.3°C

In vitro activity class: A

Chiral HPLC (ChiralCel AD 0.49 cm x 25 cm column, n-hexane / ethanol = 90 / 10, flow rate 1.5 mL/min) R-isomer was detected at 16.2 minutes.

20 Example 4-5

N-{(S)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-N'-(4-trifluoromethyl-benzyl)-urea



25 This example was performed according to the general method C.

A mixture of (S)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-carbamic acid phenyl ester (100.0 mg, 0.35 mmol) and 4-trifluoromethyl-benzylamine (61.8 mg, 0.35 mmol) in DMSO (1.5 ml) was stirred at 100°C for 1.5 hours. The reaction mixture was cooled to room temperature, and ethylacetate and water were added.

5 The extracted organic layer was washed with water then brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered and concentrated under reduced pressure. The obtained residue was triturated with dichloromethane and diisopropyl ether to obtain N-{(S)-7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl}-N'-(4-trifluoromethyl-benzyl)-urea (109 mg, 85% yield).

10  $^1\text{H}$  NMR (DMSO-*d*6)  $\delta$  1.58-1.59 (m, 1H), 1.85-1.86 (m, 1H), 2.33-2.85 (m, 4H), 3.91-3.92 (m, 1H), 4.39 (d, *J* = 5.7 Hz, 2H), 4.84 (d, *J* = 4.1 Hz, 1H), 6.72 (d, *J* = 7.25 Hz, 1H), 6.98 (t, *J* = 7.9 Hz, 1H); 7.12 (t, *J* = 6.0 Hz, 1H), 7.51-7.71 (m, 6H).

Molecular weight: 364.37

15 MS (M+H): 366

In vitro activity class: A

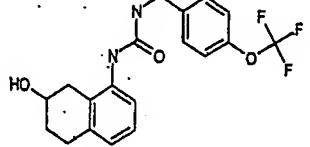
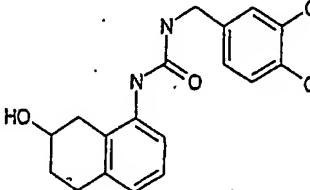
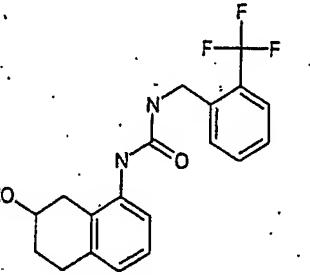
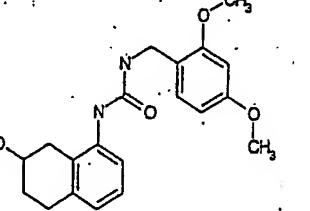
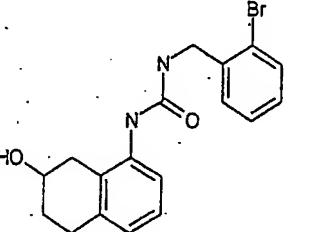
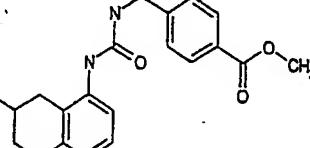
Chiral HPLC (ChiralCel AD 0.49 cm x 25 cm column, n-hexane / ethanol = 90 / 10, flow rate 1.5 mL/min) S-isomer was detected at 11.7 minutes.

20 In a similar method according to the Example 4-1, 4-2, 4-3, 4-4 and 4-5 above, the compounds in Example 4-6 to 4-54 were synthesized.

Table 2

No.	MOLSTRUCTURE	MW	MS (M+H)	MP	activity class
4-6		296,3723	297	198-200	B
4-7		375,26833	376	220.5-222	A
4-8		364,37068	365	186-187	A
4-9		330,81733	331	235 Z	A
4-10		364,37068	365	169,9	A

4-11		326,39879	327	196	B
4-12		332,35316	333	193,4	A
4-13		326,39879	327	171,3	B
4-14		330,81733	331	188,7	A
4-15		365,26236	366	212,7	A
4-16		352,48066	353	199,9	A

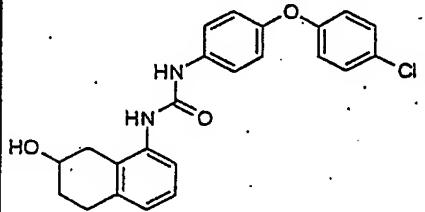
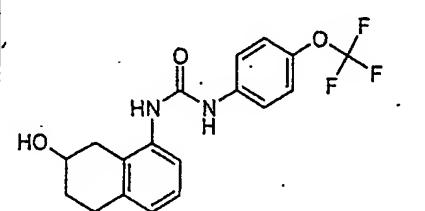
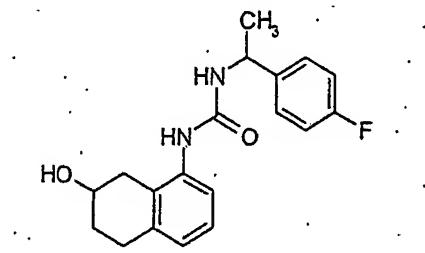
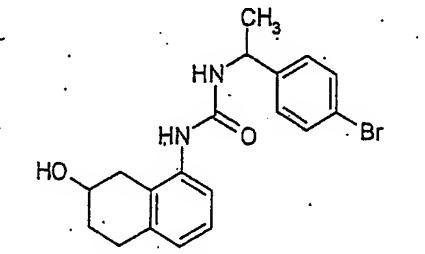
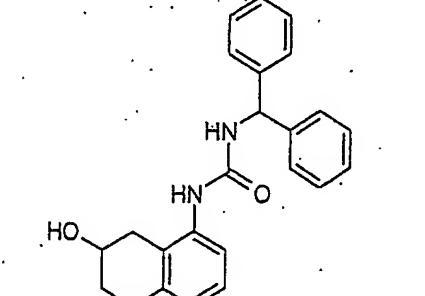
4-17		380,37008	381	213	A
4-18		365,26236	366	201,4	A
4-19		364,37068	365	218,6	A
4-20		356,42528	357	212	B
4-21		375,26833	376	206,4	A
4-22		354,40934	355	210,9	A

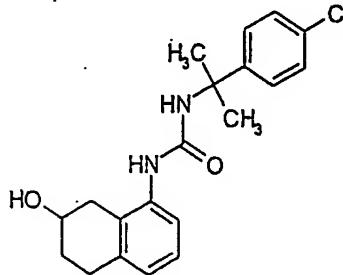
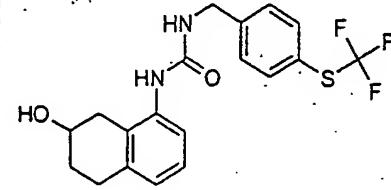
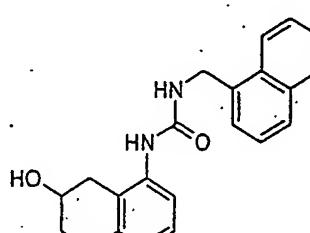
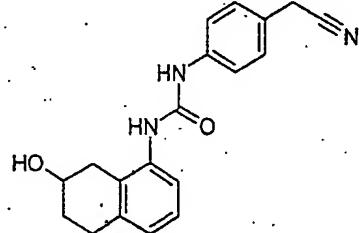
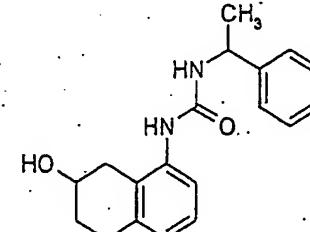
4-23		386,45177	387	175,4	C
4-24		375,26833	376	164,2	A
4-25		341,36983	342	216,3	A
4-26		432,36906	433	200,3	A
4-27		356,42528	357	219,7	C

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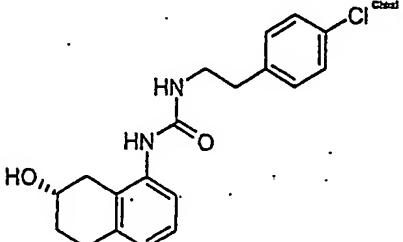
4-28		332,35316	333	140,2	C
4-29		380,37008	381	149	A
4-30		340,38225	341	278,5	C
4-31		311,38697	312	223	C
4-32		311,38697	312	132,5	C

4-33		368,43643	369	209,5	B
4-34		339,44115	340	197,7-199,5	A
4-35		398,81571	399	187,5	A
4-36		344,84442	345	>200	A
4-37		382,36111	383	174	A
4-38		388,47048	389	181-183	A

4-39		408,88842	409	199-201	A
4-40		366,34299	367	198-200	A
4-41		328,38982	329	163-164	B
4-42		389,29542	389-391	174	A
4-43		372,47108	373	205-206	C

4-44		358,87151	359	140-141	B
4-45		396,43468	397	209,1	A
4-46		346,43284	347	221,1	A
4-47		321,38218	322	147 decomp.	B
4-48		310,39939	311	169,6	B

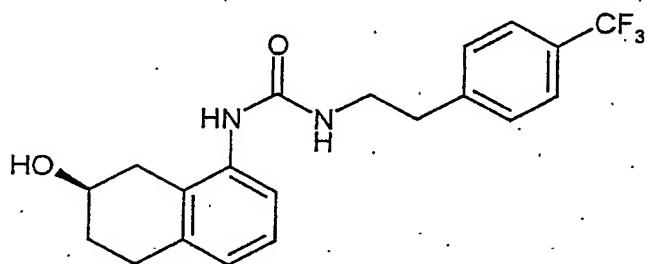
4-49		360,45993	361	137,4	A
4-50		375,44977	376	>200 decomp.	C
4-51		447,50486	448	159	A
4-52		483,96583	448	83	A
4-53		344,84442	345	173,9	A

4-54		344,84442	345	159,3	A
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Example 4-48

N-[(7R)-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-{2-[4-(trifluoromethyl)phenyl]-ethyl}urea

5



This example was performed according to the general method C.

10. A mixture of 7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-carbamic acid phenyl ester (100.0 mg, 0.35 mmol) and 2-(4-trifluoromethyl-phenyl)ethylamine (66.7 mg, 0.35 mmol) in DMSO (1.0 ml) was stirred at 60°C for 3 hours. The reaction mixture was cooled to room temperature, and the mixture was partitioned between water and ethyl acetate. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness.

15. The raw material was stirred with diethyl ether, and the precipitate was filtered and dried *in vacuo* to give N-[(7R)-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-{2-[4-(trifluoromethyl)phenyl]ethyl}urea (125 mg, 94 % yield).

20. <sup>1</sup>H NMR (DMSO-*d*<sub>6</sub>) δ 1.45-1.68 (m, 1H), 1.78-1.93 (m, 1H), 2.29 (dd, 1H), 2.65-2.93 (m, 5H), 3.39 (dt, 2H), 3.80-4.00 (m, 1H), 4.88 (d, 1H), 6.57 (t, 1H), 6.70 (d, 1H), 6.98 (t, 1H), 7.42-7.75 (m, 6 H).

Molecular weight: 378.39

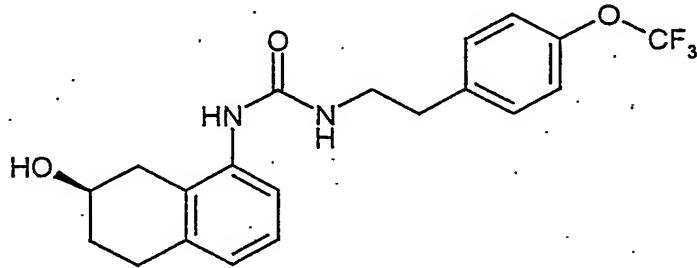
MS (M+H): 379

- 80 -

Example 4-49

N-[(7R)-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-{2-[4-(trifluoromethoxy)phenyl]-ethyl}urea

5



This example was performed according to the general method C.

10 A mixture of 7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-carbamic acid phenyl ester (100 mg, 0.35 mmol) and 2-(4-trifluoromethoxy-phenyl)ethylamine (72.4 mg, 0.35 mmol) in DMSO (1.0 ml) was stirred at 60°C for 2.5 hours. The reaction mixture was cooled to room temperature, and the mixture was partitioned between water and ethyl acetate. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness. The raw material was stirred with diethyl ether, and the precipitate was filtered and dried *in vacuo* to give N-[(7R)-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-{2-[4-(trifluoromethoxy)phenyl]ethyl}urea (109 mg, 79 % yield).

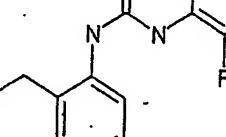
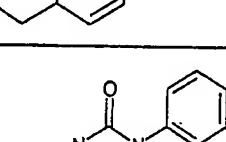
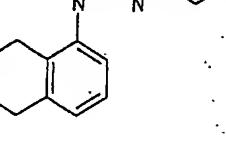
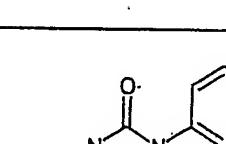
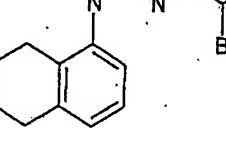
15

20 <sup>1</sup>H NMR (DMSO-*d*<sub>6</sub>) δ 1.50-1.65 (m, 1H), 1.80-1.91 (m, 1H), 2.30 (dd, 1H), 2.60-2.88 (m, 5H), 3.34 (dt, 2H), 3.85-3.97 (m, 1H), 4.81 (d, 1H), 6.55 (t, 1H), 6.70 (d, 1H), 6.98 (t, 1H), 7.30 (d, 2H), 7.38 (d, 2H), 7.50 (s, 1H), 7.59 (d, 1H).

Molecular weight: 394.39

MS (M+H): 395

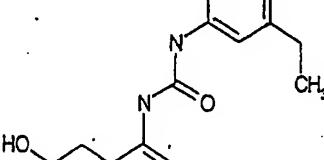
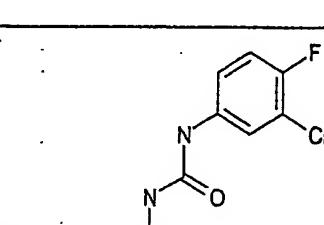
**Table 3**

No.	MOLSTRUCTURE	MW	MS (M+H)	MP	activity class
5-2		300,336	301		C
5-3		300,336	301	204-205	B
5-4		361,241	362	196-197	B
5-5		361,241	362		A
5-6		296,372	297	223	C

5-7		296,372	297		B
5-8		324,426	325		A
5-9		338,454	339		A
5-10		374,443	375	194-195	A
5-11		366,343	367	203-204	A
5-12		380,37	381		A

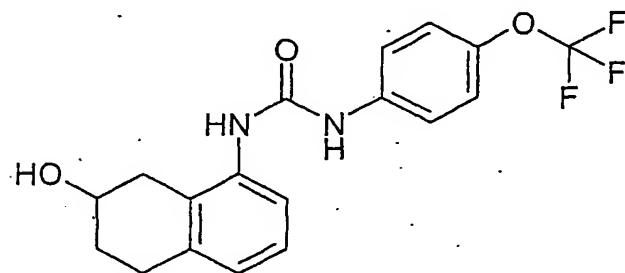
5-13		408,242	409	226-228	A
5-14		326,399	327	>192Z	A
5-15		328,371	329	>82Z	C
5-16		328,436	329	>186Z	B
5-17		330,362	331	>185Z	A

5-18		342,398	343	203-212	B
5-19		346,817	347	>200Z	A
5-20		298,345	299	>202Z	C
5-21		310,399	311	>223Z	A
5-22		310,399	311	>197Z	A

5-23		310,399	311	>142Z	A
5-24		314,363	315	>197Z	A

Example 5-1

N-(7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-N'-(4-trifluoromethoxy-phenyl)-urea



5

This example was performed according to the general method E.

A mixture of 8-amino-1,2,3,4-tetrahydro-naphthalen-2-ol (32.6 mg, 0.20 mmol) and (4-trifluoromethoxy-phenyl)-carbamic acid phenyl ester (59.5 mg, 0.20 mmol) in 10 DMSO (1.0 ml) was stirred at 100 °C for 1.5 hours. The mixture was concentrated under reduced pressure, and then purified by preparatory HPLC to obtain N-(7-hydroxy-5,6,7,8-tetrahydro-naphthalen-1-yl)-N'-(4-trifluoromethoxy-phenyl)-urea (15.5 mg, 21 % yield).

15  $^1\text{H}$  NMR (DMSO-*d*6)  $\delta$  1.61 (m, 1H), 1.87 (m, 1H), 2.40 (m, 1H), 2.85 (m, 2H), 3.96 (m, 1H), 4.88 (d, *J* = 4.2 Hz, 1H), 6.80 (d, *J* = 7.2 Hz, 1H), 7.05 (t, *J* = 7.2 Hz, 1H), 7.28 (d, *J* = 8.7 Hz, 2H), 7.55 (d, *J* = 9.3 Hz, 2H), 7.63 (d, *J* = 7.2 Hz, 1H), 7.85 (s, 1H), 9.24 (s, 1H).

Molecular weight: 366.34

MS (M+H): 367

20 mp: 198-200 °C

In vitro activity class: A.

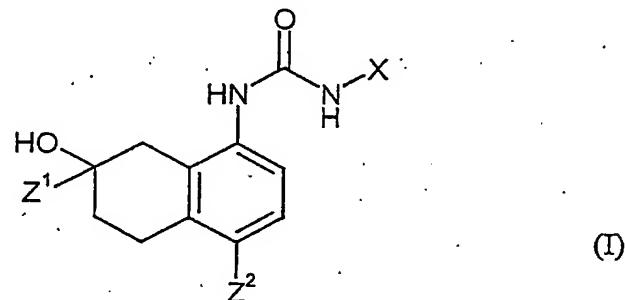
In a similar method according to the Example 5-1 above, the compounds in Example 5-2 to 5-24 were synthesized.

25

Claims

1. A hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), its tautomeric or stereoisomeric form, or a salt thereof:

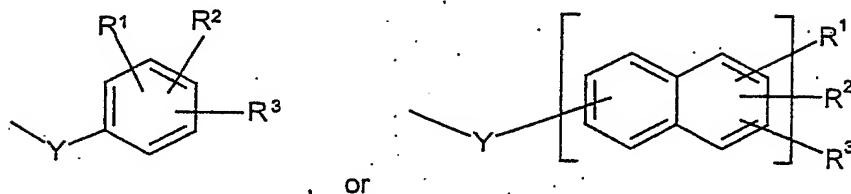
5



wherein

X represents  $C_{1-6}$  alkyl,

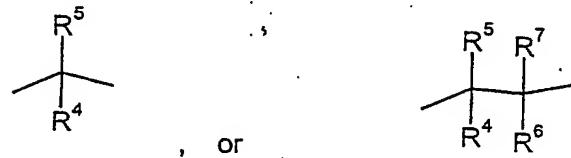
10



in which

15

Y represents a direct bond,



20

$R^1$ ,  $R^2$  and  $R^3$  independently represent hydrogen, halogen, hydroxy, nitro, carboxy, amino,  $C_{1-6}$  alkylamino, di( $C_{1-6}$  alkyl)amino,

C<sub>3-8</sub> cycloalkylamino, C<sub>1-6</sub> alkoxycarbonyl, phenyl, benzyl, sulfonamide, C<sub>1-6</sub> alkanoyl, C<sub>1-6</sub> alkanoylamino, carbamoyl, C<sub>1-6</sub> alkylcarbamoyl, cyano, C<sub>1-6</sub> alkyl optionally substituted by cyano, C<sub>1-6</sub> alkoxycarbonyl or mono-, di-, or tri-halogen, C<sub>1-6</sub> alkoxy optionally substituted by mono-, di-, or tri- halogen, phenoxy optionally substituted by halogen or C<sub>1-6</sub> alkyl, or C<sub>1-6</sub> alkylthio optionally substituted by mono-, di-, or tri- halogen;

10 R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup> and R<sup>7</sup> independently represent hydrogen, C<sub>1-6</sub> alkyl or phenyl;

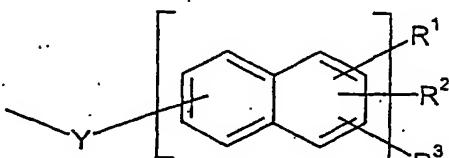
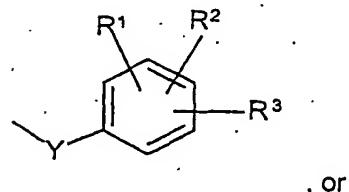
$Z^1$  represents hydrogen or  $C_{1-6}$  alkyl; and

$Z^2$  represents hydrogen, halogen or  $C_{1-6}$  alkyl.

2. The hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), its tautomeric or stereoisomeric form, or a salt thereof as claimed in claim 1,

20                   wherein

$\dot{x}$  represents

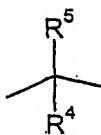


25

in which

Y represents a direct bond, or

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5                     $R^1$ ,  $R^2$  and  $R^3$  independently represent hydrogen, halogen, hydroxy, nitro, carboxyl, amino,  $C_{1-6}$  alkylamino, di( $C_{1-6}$  alkyl)amino,  $C_{3-8}$  cycloalkylamino,  $C_{1-6}$  alkoxy carbonyl, phenyl, benzyl, sulfonamide,  $C_{1-6}$  alkanoyl,  $C_{1-6}$  alkanoylamino, carbamoyl,  $C_{1-6}$  alkyl carbamoyl, cyano,  $C_{1-6}$  alkyl optionally substituted by cyano,  $C_{1-6}$  alkoxy carbonyl or mono-, di-, or tri-halogen,  $C_{1-6}$  alkoxy optionally substituted by mono-, di-, or tri-halogen, phenoxy optionally substituted by halogen or  $C_{1-6}$  alkyl, or  $C_{1-6}$  alkylthio optionally substituted by mono-, di-, or tri-halogen;

10

15                     $R^4$  and  $R^5$  independently represent hydrogen or  $C_{1-6}$  alkyl; and

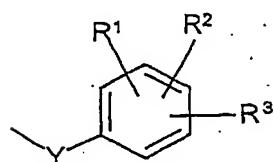
15                     $Z^1$  and  $Z^2$  each represent hydrogen.

3.                    The hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), its tautomeric or stereoisomeric form, or a salt thereof as claimed in claim 1,

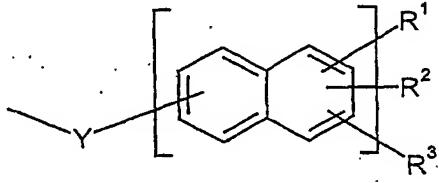
20

wherein

X                    represents



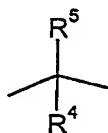
25                    or



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in which

Y represents a direct bond or



10  $R^1$ ,  $R^2$  and  $R^3$  independently represent hydrogen, halogen, di( $C_{1-6}$  alkyl)amino,  $C_{3-8}$  cycloalkylamino,  $C_{1-6}$  alkoxy carbonyl,  $C_{1-6}$  alkyl optionally substituted by cyano,  $C_{1-6}$  alkoxy carbonyl or mono-, di-, or tri-halogen,  $C_{1-6}$  alkoxy optionally substituted by mono-, di-, or tri- halogen, phenoxy optionally substituted by halogen or  $C_{1-6}$  alkyl, or  $C_{1-6}$  alkylthio optionally substituted by mono-, di-, or tri- halogen;

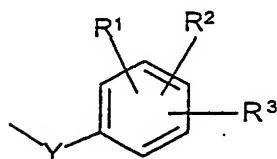
15  $R^4$  and  $R^5$  each represent hydrogen; and

$Z^1$  and  $Z^2$  each represent hydrogen.

20 4. The hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), its tautomeric or stereoisomeric form, or a salt thereof as claimed in claim 1,

25 wherein

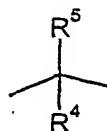
X represents



- 91 -

in which

Y represents a direct bond or



5

in which

10

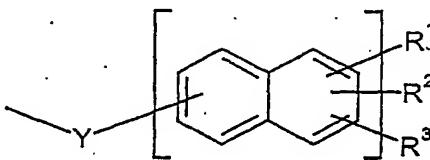
 $R^1$  and  $R^2$  independently represent hydrogen, chloro, bromo, fluoro, cyclopentylamino, trifluoromethyl, or trifluoromethoxy;

15

 $R^3$ ,  $R^4$  and  $R^5$  each represent hydrogen; and $Z^1$  and  $Z^2$  each represent hydrogen.

20

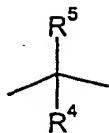
X represents



in which

25

Y represents a direct bond or



in which

5            R<sup>1</sup> and R<sup>2</sup> independently represent hydrogen, chloro, bromo, fluoro, cyclopentylamino, trifluoromethyl, or trifluoromethoxy;

10           R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> each represent hydrogen; and

15           Z<sup>1</sup> and Z<sup>2</sup> each represent hydrogen.

6.           A hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), its tautomeric or stereoisomeric form, or a salt thereof as claimed in claim 1, wherein said hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I) is selected from the group consisting of:

20           N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
 N-(3-chlorophenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[3-(trifluoromethyl)-phenyl]urea;  
 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[4-(trifluoromethyl)-phenyl]urea;  
 Ethyl 3-{{[(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)amino]carbonyl}-amino)benzoate;  
 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(1-naphthyl)urea;  
 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(2-naphthyl)urea;  
 N-(3,4-dichlorophenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-urea;

N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(4-isopropylphenyl)urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(4-phenoxyphenyl)urea;  
N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;

5 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-phenylurea;  
N-(4-chlorophenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[2-(trifluoromethyl)-phenyl]urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[4-(trifluoromethyl)-phenyl]urea;

10 N-(3,4-dichlorophenyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[4-(trifluoromethoxy)-phenyl]urea;

15 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[4-(trifluoromethoxy)-benzyl]urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-(2,4,6-trimethoxy-benzyl)urea;  
N-(2,6-difluorobenzyl)-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-urea;

20 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[4-(trifluoromethyl)-benzyl]urea;  
N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[4-(trifluoromethoxy)-benzyl]urea;

25 N-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)-N'-[4-(trifluoromethoxy)-benzyl]urea;

N-[2-(4-chlorophenyl)ethyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea; and

30 N-[3-fluoro-4-(trifluoromethyl)benzyl]-N'-(7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl)urea.

7. A hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), wherein said hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I) is selected from the group consisting of:

5

N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(*(7S)*-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]urea;

N-[4-chloro-3-(trifluoromethyl)phenyl]-N'-(*(7R)*-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]urea;

10 N-[*(7R)*-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-[4-(trifluoromethyl)benzyl]urea;

N-[*(7S)*-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-[4-(trifluoromethyl)benzyl]urea;

15 N-[*(7R)*-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-[4-(trifluoromethoxy)benzyl]urea; and

N-[*(7S)*-7-hydroxy-5,6,7,8-tetrahydro-1-naphthalenyl]-N'-[4-(trifluoromethoxy)benzyl]urea.

20 8. A medicament comprising hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), its tautomeric or stereoisomeric form, or a physiologically acceptable salt thereof as claimed in claim 1 as an active ingredient.

25 9. The medicament as claimed in claim 8, further comprising one or more pharmaceutically acceptable excipients.

10. The medicament as claimed in claim 8, wherein said hydroxy-tetrahydro-naphthalenylurea derivative of the formula (I), its tautomeric or stereoisomeric form, or a physiologically acceptable salt thereof is a VR1 antagonist.

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11. The medicament as claimed in claim 8 for the treatment and/or prevention of an urological disorder or disease.
12. The medicament as claimed in claim 11, wherein said urological disorder or disease is urge urinary incontinence or overactive bladder.
13. The medicament as claimed in claim 8 for the treatment and/or prevention of pain.
- 10 14. The medicament as claimed in claim 13, wherein said pain is chronic pain, neuropathic pain, postoperative pain, or rheumatoid arthritic pain.
- 15 15. The medicament as claimed in claim 8 for the treatment and/or prevention of a disorder or disease related to pain.
16. The medicament as claimed in claim 15, wherein said disorder or disease related to pain is neuralgia, neuropathies, algesia, nerve injury, ischaemia, neurodegeneration, or stroke.
- 20 17. The medicament as claimed in claim 8 for the treatment and/or prevention of an inflammatory disorder or disease.
18. The medicament as claimed in claim 17, wherein said inflammatory disorder or disease is asthma or COPD.
- 25 19. Use of compounds according to claim 1 for manufacturing a medicament for the treatment and/or prevention of an urological disorder or disease.
- 30 20. Use of compounds according to claim 1 for manufacturing a medicament for the treatment and/or prevention of pain.

21. Use of compounds according to claim 1 for manufacturing a medicament for the treatment and/or prevention of an inflammatory disorder or disease.
22. Process for controlling an urological disorder or disease in humans and animals by administration of a VR1-antagonistically effective amount of at least one compound according to claim 1.
23. Process for controlling pain in humans and animals by administration of a VR1-antagonistically effective amount of at least one compound according to claim 1.
24. Process for controlling an inflammatory disorder or disease in humans and animals by administration of a VR1-antagonistically effective amount of at least one compound according to claim 1.

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP03/04395

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07C275/32 C07C275/42 C07C275/40 A61K31/17 A61P13/00  
A61P29/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 C07C A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, CHEM ABS Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 00 50387 A (KIM HEE DOO ;OH UHTAEK (KR); PARK YOUNG HO (KR); SUH YOUNG GER (KR) 31 August 2000 (2000-08-31) cited in the application the whole document -----	1,8, 19-24

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the International filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

25 August 2003

Date of mailing of the International search report

04/09/2003

Name and mailing address of the ISA

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Authorized officer

Fitz, W

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/EP 03/04395

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:  
**Although claims 22–24 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.**
2.  Claims Nos.: because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3.  Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

The additional search fees were accompanied by the applicant's protest.  
 No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP 03/04395

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
WO 0050387	A 31-08-2000	AU	763824 B2	31-07-2003
		AU	2697600 A	14-09-2000
		CA	2363531 A1	31-08-2000
		CN	1342138 T	27-03-2002
		EP	1154989 A1	21-11-2001
		JP	2002537373 A	05-11-2002
		WO	0050387 A1	31-08-2000
		KR	2001014495 A	26-02-2001
		US	6476076 B1	05-11-2002

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